JUN 24 1940

ENGINEERING NEWS-RECORD

JUNE 20, 1940

Like sentinels on guard—Tainter gate piers for Austin Dam—see page 844

luding **CONSTRUCTION**

75 pages of bidding and esti

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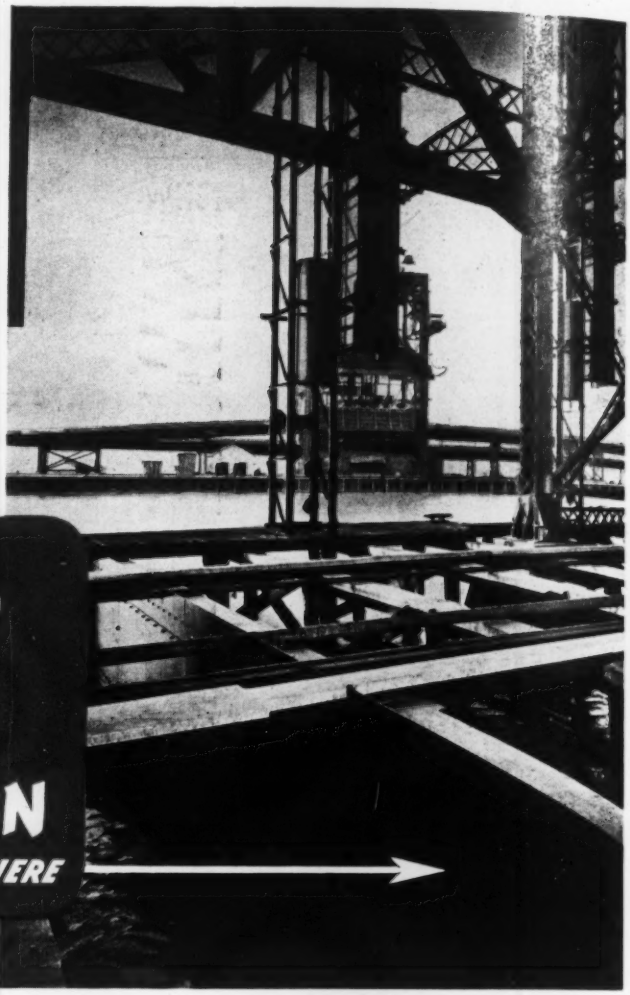
Dependable fire protection for Pier substructures



FIRE CURTAINS OF BYERS WROUGHT IRON HERE

A disastrous fire which destroyed a great pier some years ago dramatically demonstrated the importance of sub-deck fire protection. Adequate land and water fire apparatus was available, but could not reach the flames beneath the floor. The illustration shows how engineers guard against such fires today, with fire curtains of genuine wrought iron. This curtain is installed on the Norfolk and Western Railway Company Pier at Norfolk, Va. Byers Wrought Iron Plates were used.

In a magazine article describing one of the first wrought iron fire stop installations, the editor wrote, "Consideration was given to constructing the fire stops of certain other materials, but wrought iron was selected for several reasons, the more important being its high resistance to the corrosive action of sea water, and its ability to absorb, without damage, any shocks to or actual movement of the piers as a result of their being struck by lighters, tugs or other . . . boats." Today, as then, these properties of wrought iron provide the strongest arguments for its use. Piers at New York, Jersey City, and Baltimore are all protected with curtains of wrought iron.

Our Engineering Service Department will be glad to give you full details on any of these installations, if you have a similar problem. You will also find some interesting data in our bulletin, "Wrought Iron in Salt Water Services." Ask for a copy.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

Corrosion costs you more than Wrought Iron

BYERS GENUINE WROUGHT IRON

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ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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Number of copies of this issue printed: 35,500

THIS WEEK

● Stability at high levels characterized the construction cost picture during 1939. This week, *News-Record* presents its annual resume, 75 pages packed with informative work data for engineering and contracting forces concerned with planning, bidding, appraisal and valuations, in addition to its regular editorial content. This section covers wide variety of cost data—railroads, public utilities, roadbuilding; housing costs—municipal, USHA, federal; material prices, bond interest and money rates, labor equipment rentals, unit bid prices, etc.

● From laminated timber arches for buildings to a self-anchored I-girder suspension bridge, this issue carries a wealth of additional material of vital interest.

● Taking the laboratory to the samples—a new idea in conducting field tests inaugurated by the U. S. Public Health Service on the Ohio River pollution survey—is the subject of an instructive article.

● Historic Austin Dam Rebuilt—a brief pictorial and descriptive record vividly portraying the five stages in its development that have followed recurring failures since the original was built in 1893. The new Austin Dam is integrated in a system of four dams designed for flood-control and development on the Colorado River of Texas.

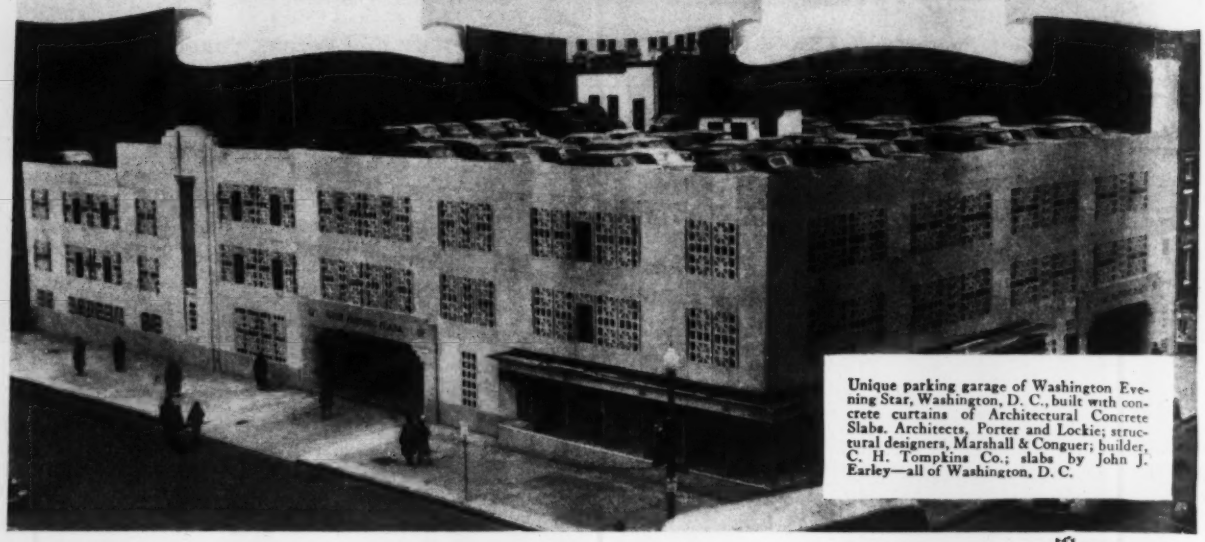
THINGS TO COME

LIFTING a River over a Levee—an old problem solved in a new way. Departing from conventional practice U. S. Army Engineers installed a siphon to replace a sluiceway on the St. Francis River project. By extensive research on siphon hydraulics a structure was designed with a discharge coefficient of 0.97 as contrasted to the previously established value of 0.75. Hydraulic, structural design and performance data will appear in the forthcoming July 4 *News-Record*.

THE GOOD OLD DAYS of contracting were before the World War, according to E. L. Copeland, of Bates and Rogers Construction Co. His reminiscences of 35 years in the business will be published in an early issue.

CURTAINS OF CONCRETE

two inches thin!



Unique parking garage of Washington Evening Star, Washington, D. C., built with concrete curtains of Architectural Concrete Slabs. Architects, Porter and Lockie; structural designers, Marshall & Conguer; builder, C. H. Tompkins Co.; slabs by John J. Earley—all of Washington, D. C.

Architectural Concrete Slabs, hung from the floors, provide strongly reinforced curtain walls that eliminate cost of fenestration and sprinkler system, and give adequate light and ventilation for three-story garage.

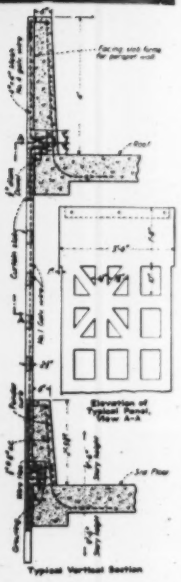
THAT is part of the story of a unique parking structure built at unusually low cost in Washington, D. C. In addition, these thin slabs—little more than 2″ thick, yet with strengths of 8,000 to 10,000 pounds per square inch—eliminated the need for 9″ masonry walls and reduced the support such walls normally require. Also, the slabs served as forms for the parapet and the fender curbs, as shown in the accompanying diagram.

These thin Architectural Concrete Slabs were designed and erected as a concrete curtain between the open structure and the street. The slabs, approximately 3½′ x 9½′ and reinforced with heavy 4″ x 4″ welded galvanized mesh, were hung from the floors. The lacework design combined with the lustre of exposed yellow quartz aggregate imbedded in a matrix of Atlas White Cement answered the demand for an attractive exterior.

What are Architectural Concrete Slabs?

Factory-made units of reinforced concrete made with selected aggregates exposed in a matrix of Atlas White portland cement. Slabs are precast in sizes up to 100 square feet or more, and 20 feet or more in length, yet are only 2 inches thick. They are made in many shapes, including curves, angles, channels; monolithic units that are wrapped around corners; and spandrels that include window head and window sill. They may be plain or patterned in a wide variety of colors and textures.

Write for further information on slabs for new or old construction—for interior as well as exterior walls—or see SWEET'S CATALOG—Building File. Universal Atlas Cement Co. (United States Steel Corp. Subsidiary), Chrysler Building, New York City.



Cross section showing how slabs are attached to garage floors. Also elevation view of slab section, A-A. Diagram shows that lug returns at top and bottom are cast monolithically with the facing slab, are fitted with tongue and groove, and anchored with dowels and reinforcing ties over which the fender curb is subsequently placed. Facing slabs also were used as the outer form for the parapet wall and fender curb.

NR-ACS-26

ARCHITECTURAL CONCRETE SLABS

MADE WITH ATLAS WHITE CEMENT

ENGINEERING NEWS-RECORD

NEWS

Volume 124 JUNE 20, 1940 Number 25

Turnpike, Mobile Tunnel Openings Delayed

The 160-mile Pennsylvania Turnpike, originally scheduled for dedication July 4, and the $34,000,000 Bankhead Tunnel being built at Mobile, Ala., originally scheduled for completion July 1, will not be placed in service until later dates.

Although it is rumored that the Turnpike will be opened on Labor Day, officials decline to verify this date. On the other hand, Wayne Palmer, of Wilberding & Palmer, Inc., consulting engineers for the Mobile tunnel, reports that this project will be opened August 17. Arrangements are being made for extension of the deadline for the Mobile project from June 30 to December 1, to permit some work to be postponed until after the tunnel is in operation.

• • •

Chicago Plan Commission Holds First Meeting

Reorganization of the Chicago Plan Commission, authorized a year ago but with members only recently appointed, was signalized by the first meeting June 11. The newly appointed president, George T. Horton, president of the Chicago Bridge & Iron Works and a civil engineer, and the other 25 members were called together by Mayor E. J. Kelly, also an engineer, for preliminary instructions as to their duties. Mayor Kelly spoke of the possibility of the construction with federal funds of an island airport for which the old commission long ago prepared plans. Philip Harrington, commissioner of subways and superhighways, indicated that superhighways were favorably looked upon by the Public Roads Administration as of military necessity.

Immediately ahead of the commission is the rezoning of the city based on the $2,000,000 WPA land-use survey nearing completion under the direction of Hugh E. Young, engineer of the old commission.

James Jardine, an engineer with the Chicago traffic bureau, was appointed acting secretary.

Navy Awards Fee Contract For Corpus Christi Airbase

Contractors to get $1,200,000 as fee for doing $23,381,000 job under new contract powers of Navy

The Navy last week made the first use of its new authority to award negotiated contracts for work within the United States when it completed a cost-plus-a-free contract with three firms to build the new Corpus Christi, Texas, training base (*ENR*, June 13, p. 825). The work, estimated to cost $23,381,000, will be done jointly by Brown & Root of Houston, W. S. Bellows of Houston, and Columbia Construction Co. of Oakland. The contractors will receive a fee of $1,200,000.

In awarding this contract, the Navy followed the same procedure and used the same form of contract which was developed last year in connection with the cost-plus work on overseas naval bases. A group of contractors selected from a list of about 250 firms in the files of the Bureau of Yards and Docks was called in and examined as to their ability to do the work. Selection was entirely on the basis of fitness.

The fee is set by the Navy; it is computed to cover profit, interest on money, expenses of the contractor's central office, and services of company officials and central office employees. In setting the fee account is also taken of the degree of disruption of the contractor's normal activities. All other items are chargeable as cost to be reimbursed by the government.

Elements of the contract

Since the Navy conceives of the relation embodied in a negotiated contract as one of partnership rather than the buyer-seller relation of a competitive contract, the contract document is relatively short and simple.

The contract requires that the contractor furnish all plant, materials, and labor. Plant rental is paid according to a pre-arranged schedule designed to cover insurance, depreciation, taxes, and cost of operation. Repair of equipment at the end of the job to get it back to original shape can be charged as a cost. Materials become the property of the government as soon as the contractor takes delivery, thus avoiding

(Continued on page 45)

New York Contractors Ask War Risk Protection

The effect of war conditions on building contracts in the New York area was emphasized this week when contractors contemplating bidding on building work requested the letting authorities to include clauses in the contracts protecting them from: (1) increased cost of construction, with payments based on changes in an agreed New York construction cost trend index; (2) delays due to the failure to receive material occasioned by factors beyond the contractor's control; and (3) governmental interference with operations, personnel and material. The right to terminate the contract also was asked if the contractor is delayed more than a specified time for any reason, but principally for failure to receive materials.

The attitude of the city agencies has not been ascertained but the Department of Docks took no action on a request for inclusion of the desired changes in bids opened June 18 for a land plane hangar at LaGuardia Field, for which James Stewart & Co., Inc., of New York, submitted the apparent low bid of $516,480.

The contractors requesting these changes are a group generally bidding on buildings under various contract agencies of the city of New York. Fifteen contractors of this classification have started an organization to be known as the Public Buildings Contractors' Association.

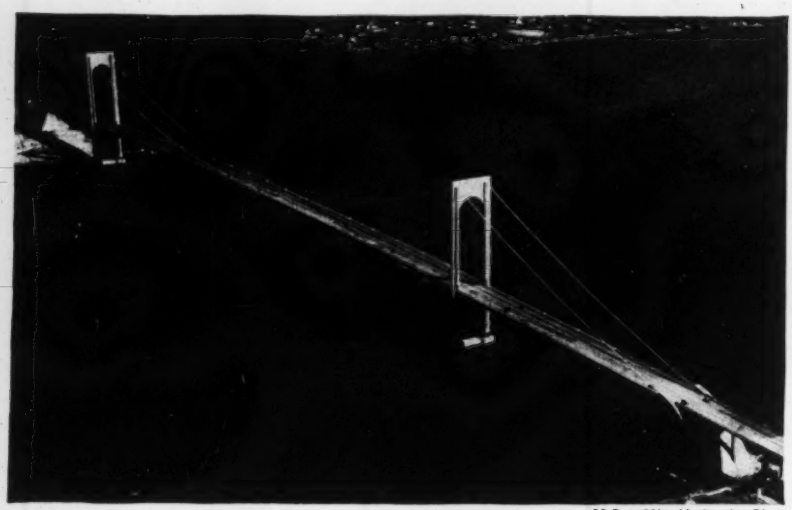
Awards for Year's Beautiful Bridges

Results of the annual judging of the most beautiful steel bridges of the year conducted by the American Institute of Steel Construction and announced on June 20 places the Bronx Whitestone Bridge first among monumental structures opened in 1939, a TVA foot bridge at Murphy, N. C., first in the small bridge class and the Thunder Bay River bridge at Alpena, Mich., first for movable bridges. No prize award was made for medium size bridges, although two structures received honorable mention.

The 1939 Jury of Award consisted of Hale Sutherland, Lehigh University, J. K. Finch, Columbia University, Francis Keally and Louis E. Jallade, New York architects, and Roger W. Sherman, managing editor of *Architectural Record*.

Data on the prize and honorable mention bridges follow:

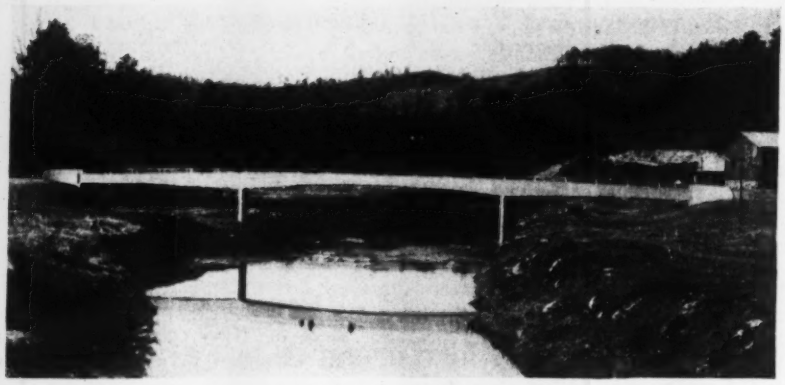
BRONX-WHITESTONE—First Place in Class A—Across the East River, New York City; Total Cost, $10,000,000; Engineers: Triborough Bridge Authority, O. H. Ammann, chief engineer; Allston Dana, engineer of design; Leon S. Moisseiff, consulting engineer on design; Aymar Embury, II, architect; Madigan-Hyland, consulting engineers on construction; H. W. Hudson, engineer of construction; Fabricators, American Bridge Co.



McLaughlin Air Service Photo

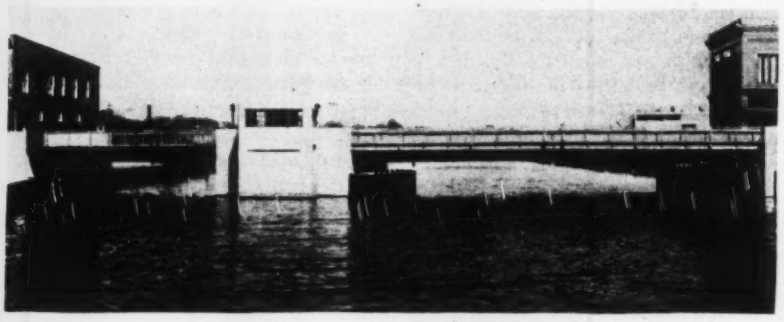
BRONX-WHITESTONE BRIDGE, NEW YORK CITY

VALLEY RIVER FOOTBRIDGE—First Place in Class C—Murphy, North Carolina; Total Cost $6,000; Engineers: Tennessee Valley Authority, T. B. Parker, chief engineer; Harry A. Hageman, chief design engineer; F. W. Webster, head highway engineer; Erwin Harsch, senior structural engineer; Fabricators, Lloyd E. Jones Co.



VALLEY RIVER FOOTBRIDGE, MURPHY, N. C.

THUNDER BAY—First Place in Movable Bridges—At Second Ave., Alpena, Michigan; Total Cost, $289,000; Engineer, Clifford E. Paine; Fabricators, The R. C. Mahon Co. Double leaf bascule, 127 ft. c-c main trunnions; approach span 49 ft.



THUNDER BAY BRIDGE, ALPENA, MICHIGAN

HIGHLAND PARK AT PITTSBURGH, Honorable Mention in Class A—Over the Allegheny River, Total Cost, $2,409,126; Engineers: Allegheny County Department of Works, John F. Laboon, director; Levi Bird Duff, chief engineer; Parsons Klapp, Brinckerhoff & Douglas, advisory engineers, with Waddell & Hardesty as associate engineers; Fabricators, Bethlehem Steel Company; 1,716.9 ft. total length of river spans; approach spans (girder) 6 spans, 588 ft.

HOWARD ST., Baltimore, Maryland—First Honorable Mention in Class B—Total Cost $936,000; Engineers: J. E. Greiner Co.; Fabricators, American Bridge Co. Span lengths: 2 tied arches 272.38 ft. each 3 deck girders, 109 ft., 122.92 ft. and 101.58 ft.; total length, 972 ft.

GROVE, OKLA.—Second Honorable Mention in Class B—Total cost $369,000; Engineers: designed by Victor H. Cochrane, for Holway & Neuffer, engineers for the Grand River Dam Authority; Fabricators: Virginia Bridge Co. (main trusses); Patterson Steel Co. (approach spans). Span lengths: 15 main spans at 120 ft.; 12 I-beam spans at 60 ft.

WAVERLY BRIDGE—Honorable Mention in Class C.—Near Lansing, Michigan; Total Cost $78,050; Engineers; J. G. Rakowsky, Ingham County engineer (in charge); F. A. McCowan, assistant engineer (design and inspection); Fabricators, The R. C. Mahon Co.; Owners, Ingham County Road Commission-Eaton County Road Commission; Span lengths 5 at 60 ft.

ILLINOIS GRADE SEPARATION—Honorable Mention in Class C—On U. S. 66, Mazonia, Illinois; over Alton R.R.; Total Cost, $146,148; Engineers: Ernst Lieberman, chief highway engineer; Alfred Benesch, engineer of grade separations; Fabricators, Bethlehem Steel Co.; Span lengths: south approach, two-span continuous I-beams; main span, 250 ft. steel tied arch; north approach, 4-span continuous I-beam deck; total length 1,059 ft.

MIAMI, FLORIDA—Honorable Mention in Movable Bridges—Over Miami River at N.W. 27th Ave.; Total Cost, $388,152. Engineers: Edmund Friedman, county engineer, Dade County, Florida; Harrington and Cortelyou, consulting engineers; Fabricators, Nashville Bridg Co.; Span lengths; bascule span 148 ft. c-c of trunnions; two approach spans 52 ft. 2 in. each; length of structure abutment to abutment, 294 ft. 8 in.

• • •

Right-of-Way Provided For Blue Ridge Parkway

A bill providing for a right-of-way for the Blue Ridge Parkway through the Cherokee Indian reservation in western North Carolina was signed June 12 by President Roosevelt. The bill authorizes the Secretary of the Interior to sell the right-of-way to the state of North Carolina for $30 an acre or a lump sum of $40,000, whichever amount should prove to be the

greater. The money will be held in trust for the Indians by the federal government.

The right-of-way, subject of a lengthy controversy between North Carolina highway officials and Cherokee Indian leaders, will connect the Shenandoah National Park and the Great Smoky Mountain National Park. The right-of-way provided is for a road beginning near Soco Gap and extending to a point near the mouth of Raven's Fork of the Oconoluftee River.

• • •

Special Earthquake Designs Survived Recent Shock

Eyewitness accounts of Imperial Valley earthquake damage (*ENR*, May 23 and May 30, 1940) were presented and analysed at a meeting of the Structural Engineers Association of Northern California, June 4, by F. P. Ulrich, U. S. Coast and Geodetic Survey; D. C. Willett, California Division of Architecture, and H. M. Engle, Board of Fire Underwriters of the Pacific.

All speakers agreed that the shock was severe. Numerous displacements of tree rows, roads and fences are on the order of 12 ft; the first shock, intensity about 10 on the modified Mercali scale, came at 8:37 p.m., had a duration of 26 seconds and was followed by other heavy shocks at 9:40 and 10:34 p.m. that doubtless greatly increased the initial damage. These subsequent shocks followed much sooner than was the case at Helena, Mont.

As a whole, data presented at the meeting supported the following conclusions:

(1) Structures designed to resist horizontal forces of 0.08 and 0.1g, using a static method of analysis, were undamaged. This is supported by the condition of structures in wood, steel skeleton frame and concrete. Buildings not designed for horizontal forces were heavily damaged.

(2) In the design of tall steel water tank towers, the use of a lateral force coefficient of 0.1g again proved to be effective. Of the two towers absolutely undamaged, one was originally designed for a 0.1g lateral force (static analysis) and the other was an old wind-braced tower that had been rebraced and strengthened to conform to the requirements of the Board of Fire Underwriters of the Pacific. Of the six towers whose design provided only for the standard type of wind bracing, four were seriously damaged with stretched and sagging bracing rods and the other two collapsed into total wrecks of torn and twisted steel.

(3) Buildings damaged even to a moderate degree in an earthquake are poor risks in subsequent shocks unless adequate repairs are made with care.

(4) The effectiveness of reinforced wall construction was again demonstrated by the behavior of a number of one-story buildings (mostly market or garage type) with reinforced concrete walls and trussed roofs. Resistance of these structures was markedly superior in most cases to that of similar structures with unreinforced walls.

• • •

Corpus Christi Contract

(*Continued from p.* 43)

insurance and tax costs. Wages and hours of labor are determined by the contracting officer, and all personnel must be satisfactory to him.

The work is to be done in accordance with whatever plans are furnished by the Navy, and the plans may be changed at any time; if the changes alter the magnitude of the job an adjustment will be made in the fee. On the Pacific bases a completion time was written into the contract, but no provision was made for liquidated damages.

The contract may be terminated by the Navy at any time, in which case the contractor will be paid for his costs to date and an equitable portion of the fee, while the government will assume all his outstanding obligations. If the termination is due to a fault of the contractor, the government may take his equipment, paying rental, to complete the job.

Army contracts

Legislation to give the Army power to enter into negotiated contracts is still in the works. A hitch has arisen in the form of a Senate amendment forbidding "cost-plus" contracts. It is believed that this provision will be eliminated in conference. If it is not, a legal decision will be necessary as to whether the prohibition applies to fixed-fee contracts.

Supplemental Defense Bill Adds $200,000,000 More Construction

Covers President's requests after army and navy bills had passed; Senate may increase work approved by House

More than $200,000,000 of additional military construction is included in the $1,700,000,000 supplemental defense appropriation as it passed the House. This bill covers the military requests made by the President after the enhanced army and navy bills had gone through. The bill is now before the Senate appropriations committee, and, as a result of the surrender of France, it will probably be substantially increased. Some of these increases will doubtless involve construction; there is talk of expenditure of $50,000,000 on new shipyards.

By present indications, and subject to instant revision, the defense program as it finally shapes up will include about a half billion dollars of direct federal construction.

Construction for the Army in the supplemental bill totals $81,424,000 and is almost wholly made up of housing. More or less permanent barracks and quarters account for $7,101,000, while $71,421,000 is for temporary shelter necessitated by an increase in the army from 280,000 men to 375,000 men. In addition, $2,900,000 is provided for bomb storage facilities. All of this work will be widely scattered throughout the country.

For Navy public works, the bill provides $102,200,000. The biggest item in this is $51,800,000 to start work on about $100,000,000 of airbases previously authorized but for which money has not previously been available (*ENR*, June 13, p. 3). Another $10,000,000 is for auxiliary and naval reserve airbase facilities at various points. To start a $30,000,000 program for expansion of shipbuilding facilities $12,000,000 is provided; with the exception of a $10,000,000 shipbuilding dock at the Philadelphia Navy Yard, this consists mostly of small items.

By far the largest among the airbases in the United States are the $24,204,000 Quonsett Point, R. I. and the $13,246,000 Norfolk, Va. bases. Both of these represent large expansions of very small existing air facilities. The expansion reflects a current shift in emphasis in Navy thinking from shipbased aircraft for fleet operations to shorebased aircraft. These two bases, together with the large bases under construction at Jacksonville and Puerto Rico, will provide storage and repair facilities and in general form the home port for naval aircraft operating along the Atlantic seaboard.

Construction at these and the other bases contemplated will be temporary in nature or similar to that at Corpus Christi. This is not so much that the bases are not permanent but more in the interests of quick construction. It is believed that the program can be completed within a year and a half, and that planes can be operated from the bases within nine months or so.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

GANO DUNN, president of J. G. White Engineering Co. and of Cooper Union College, has been named to the staff of Edward R. Stettinius Jr., of the National Defense Advisory Commission. W. Averell Harriman of the Union Pacific R. R., and Walter S. Tower, president of American Iron and Steel Institute, are other staff members. Harriman will act as liasion between Stettinius and Ralph Budd, president of Chicago, Burlington & Quincy R. R. and member of National Defense Commission. Tower will advise Stettinius on the steel industry.

IMPLEMENTING the President's suggestion that USHA facilities be used to provide housing around expanded military stations, the housing authority has approved loans for two such projects. A loan of $643,000 to the Pensacola, Fla., housing authority will provide a 200-unit project at the Navy's training school there, and a $1,305,000 loan to the Montgomery, Ala., authority will finance a 424-unit project near the Army's Maxwell Field airbase. Because all USHA money is now allocated, it was necessary, in order to approve these projects, to rescind earmarkings for other communities which have been slow in pushing their projects. Although these projects will be owned, as usual, by the local housing authorities and the usual local contribution will be required, they will be located adjacent to the military bases, several miles out of town. The apartments will be reserved for enlisted men with families and for civilian employees earning less than $85 per month.

A MAJOR NATIONAL DEFENSE EFFORT, Army experts testified before the House committee considering the supplemental defense appropriations, would require the expenditure of about a billion dollars in additional plant construction—mostly for the production of ordnance items not available from peacetime industry. Of this sum about $600,000,000 would go for machine tools and equipment and a large part of the remainder, presumably, would be for construction. The pending bill would provide $200,000,000 to start this work, and a large part of the President's $400,000,000 "blank check" in the regular appropriations would go for the same purpose. Most urgently needed items, it was testified, are aircraft production facilities costing $180,000,000, and plants for production of smokeless powder, TNT, armor plate, and airplane armament costing $200,000,000.

TO COORDINATE all research activity connected with the defense program except that involving aircraft, the President has named a National Defense Research Committee, headed by Vannevar Bush, president of the Carnegie Institution of Washington. Other members are J. B. Conant, president of Harvard; Richard C. Tolman, Caltech; Karl Compton, M.I.T.; Conway P. Coe, Commissioner of Patents; Lyman J. Briggs, director of the Bureau of Standards; F. B. Jewett, president of the National Academy of Sciences; and the secretaries of War and Navy.

AT THE INSISTENCE of the President the Senate Committee cut eight projects costing $6,100,000 out of the House-approved special river and harbor authorization bill restricted to defense projects (*ENR*, June 6, 1940, p. 767). As reported by the committee the bill now contains fifteen projects costing $18,692,000.

SMALL RECLAMATION reservoir projects costing less than $50,000 may be built without specific authorization under the terms of a bill now being studied by Congress.

Debris Dam Contract Cancelled Due to Slide

Acting as a result of the slide early last March at Ruck-a-Chucky Dam on the Middle Fork of the American River in California, the Corps of Engineers has cancelled the $643,450 contract held by George Pollock Construction Co. of Sacramento for construction of the dam. Cancellation of the contract, according to a Corps of Engineers spokesman, does not indicate that the contractor was at fault but that it has proven impossible to work out a satisfactory change-order to cover the situation.

It has also been made known that cancellation of the contract does not necesssarily indicate that the project will be abandoned, since the investigation to show how to deal with the problem, including study of a new location, continues.

The Ruck-a-Chucky work, which calls for construction of a concrete arch dam, was started last September with a little concrete placed at the time of the slide. The dam is one of a series for storing mining debris that would otherwise clog streams of that area in violation of a California law. I. E. Burks is engineer in charge for the Bureau of Reclamation.

JOBS OF THE WEEK

MACHINE AND PRESS SHOP, Highland Park, Mich.

O. W. Burke Co., Detroit, Mich., awarded contract by Chrysler Corp., for brick, steel, concrete machine and press shop, $1,000,000. Albert Kahn, Inc., Detroit, engineer.

AIRBASE HOUSING, Dayton, Ohio

William R. Goss Co., Chicago, Ill., awarded general contract for 604-unit McCook Field Housing Project, $1,287,000. Plumbing, heating and electrical work were awarded separately.

STATE HOSPITAL, Deer Park, N. Y.

P. J. Carlin Construction Co., New York, was low bidder on general contract for medical and surgical building No. 2 at new state hospital, for Department Mental Hygiene, Albany, $2,147,000. William E. Haugaard is state commission of architecture, Thomas F. Farrell, chief engineer.

BEAUHARNOIS POWER, Quebec

Foundation Co., Ltd., Montreal, awarded contract by Beauharnois Light, Heat & Power Co., Ltd., Montreal, extending north and south dams at head of Coteau Rapids, to permit 30,000 cfs additional diversion of St. Lawrence River water, which will increase power output from 420,000 to 680,000 hp for war industries. Estimated cost $1,000,000.

COTTAGE GROVE DAM, Oregon

T. E. Connolly, San Francisco, Calif., low bidder for constructing 2,100-ft. rolled earth dam, 92 ft. high on Coast Fork, Willamette River, at $769,930, for U. S. Engineers.

NOTE—Additional bidding and contract news on over 600 projects, large and small, appears in the Construction News Section beginning on page 219.

Canada's Airbase Grading Contracts on New Basis

The competitive method of awarding contracts for clearing airbase sites for the Commonwealth Air Training Plan in Canada has been stopped and a plan substituted whereby the work will be done on a unit basis, according to Transport Minister, C. D. Howe. The program will call for an expenditure of $52,000,000 before the end of the summer. Since it was started it has been found that it will require practically all the earthmoving equipment in Canada, hence it has been decided to allocate the work not already under contract to contractors on the basis of the equipment they have available, paying them a unit price based on the unit prices in the bids for the initial contracts.

Nation's Engineering Schools Drawn Into National Defense Program

Costing $14,000,000, the program, includes subsidization of short courses in technical specialties needed by industry

The engineering schools of the country are to be drawn into the national defense program through a plan being formulated at the request of the President by Commissioner John W. Studebaker of the U. S. Office of Education. The plan, which was formulated at two Washington meetings in recent weeks of deans of engineering schools, includes federal subsidization of short intense courses in technical specialties needed by industry in carrying out the defense program. Cost is expected to be about $14,000,000; this will provide for 20,000 students at $700 each. It has not yet been decided whether the money will come from a special deficiency appropriation or from the $400,000,000 "blank check" provided for the President in the defense appropriations.

Physical and administrative facilities of existing engineering schools would be used to offer six-weeks to year courses in subjects ranging from drafting to cryptology. Teaching staffs would be drawn in part from present faculties and in part from men especially hired from industry.

Subjects to be taught at each of the 140 engineering schools expected to enter the program would be determined in conference with nearby industrialists, so that each school would provide skills needed in its region.

Some present students at engineering schools might be among those taking the courses, but most would be drawn from other sources. One group would consist of graduates of engineering schools or general college courses who could profit from brief studies in specialties now in demand. Another group would be semi-professional technicians, frequently men who have been through an apprenticeship or a short-course engineering school of less than college grade; such men could quickly be raised, in specific fields, to a professional level. Finally, supervisory workers—foremen, office managers, and the like—would be given advanced training in such things as blue-print reading and specification writing.

It is likely that the whole program will soon be put in charge of Sidney Hillman of the defense commission.

Engineering educators who cooperated in drafting the engineering school plan are as follows: Karl T. Compton, Massachusetts Institute of Technology; Philip S. Donnell, Oklahoma A. & M.; F. M. Feiker, George Washington University; O. J. Ferguson, University of Nebraska; Gibb Gilchrist, Texas A. & M. College; Robert C. Gowdy, University of Cincinnati; Thorndike Saville, New York University; A. J. Scullen, Catholic University of America; S. S. Steinberg, University of Maryland; C. V. Thomas, Fenn College; B. R. Van Leer, North Carolina State College; and C. C. Williams, Lehigh University.

Dallin Aerial Surveys Photo

PHILADELPHIA NEW $10,000,000 AIRPORT OPENED JUNE 20

ABOUT TEN YEARS AGO a tract of virgin land was obtained from the federal government by the city of Philadelphia with the stipulation that an air-rail-marine terminal be constructed on the site. June 20, as the outcome, a new $10,000,000 airport covering 494 acres was opened seven miles from Philadelphia's city hall.

A small air-rail-marine terminal was first designed but the work was dropped during the depression. Several years later, as a WPA undertaking, an airport was begun with placement of a 9-ft. fill over the entire area required.

The field is laid out so that every runway can later be duplicated with a new parallel runway about 500 to 600 ft. to the side. The present runways, which vary in length from 4,500 to 5,400 ft. and in width from 150 to 200 ft., are surfaced with bituminous concrete. The $140,000 administration building, just to the left of the runway running nearly vertical in the above view, is but a temporary structure since it will be replaced later with a larger building. The surrounding area has been zoned so that the field can be kept free of obstacles.

The major part of the work was done by the Philadelphia department of public works of which John J. Neeson is director. J. Victor Dallin, former head of the Dallin Aerial Surveys and adviser on the project, is to be manager of the new field.

Philadelphia's new field will, it is expected, replace the Camden, N. J. airport as the city's main terminal, much as North Beach replaced Newark airport at New York.

Clarence W. Dunham Joins Yale Teaching Staff

Clarence W. Dunham, chief structural designer for the Phelps-Dodge Corp., has been appointed assistant professor of civil engineering at Yale University. His new duties will start in September. Following his graduation from Rensselaer Polytechnic Institute, Dunham served as instructor at that school for three years. For four years he was with the Bethlehem Steel Co., Bethlehem, Pa., advancing to assistant chief draftsman in charge of the bridge division of the drawing room. From 1927 to 1939, excepting one year spent as principal assistant to William Russell Davis of Albany, N. Y., he was connected with the Port of New York Authority as assistant engineer on the design of such works as the George Washington Bridge, Bayonne Bridge, and the Lincoln Tunnel. During a large part of the past year Dunham has acted as chief structural designer for the Phelps-Dodge Corporation.

OBITUARY

JACOB SHUFORD GEITNER, 39, former member of the engineering staffs of the Florida State Highway Department and the North Carolina Highway and Public Works Commission, died in Hickory, N. C., June 10. Geitner had also worked with the engineering department of the Duke Power Co. He received his education at Georgia Tech and North Carolina State College.

JOHN P. HARTMAN, engineer in charge of the design of the embankment for Denison Dam, died June 9 in Denison, Tex. Following his graduation from Purdue University in 1930, Hartman spent a year at M.I.T. in post-graduate work. During 1934 and 1935 he was employed as assistant in the soils laboratory at Zanesville, Ohio, by the U. S. Engineers. From Zanesville Hartman went to Fort Peck Dam where he remained two years. Before going to Denison he spent a brief assignment at the U. S. Engineers office in Louisville, Ky.

MURTHA P. QUINN, 81, vice-president of the Board of City Trusts of Philadelphia, died June 8 in that city. Quinn, retired building contractor, was at one time president of the Bethlehem City, Holmesburg, Disston, Philadelphia and Bristol and Lancaster water companies. Following his education at Lehigh University, Quinn worked for a time for the railroad contracting firm of E. J. Gaynor & Sons, Pottsville, Pa.

HENRY WALLACE WATSON, 55, senior surveyor of the Department of Public Works of Philadelphia, died June 10 in that city.

THOMAS G. GALLAGHER, 84, construction engineer employed by the Philadelphia Gas Works for thirty years, died in Edgely, Pa., June 12. Gallagher retired 11 years ago.

H. B. HENNING, 37, superintendent of the Norman Construction Co., Lafayette, La., died last week from injuries received in an automobile accident near Thibodaux, La.

GEORGE NYMAN, 41, steel designing engineer with the Carnegie-Illinois Steel Co. at Gary Ind. since 1926, died in that city June 16. Nyman came to this country from Finland twenty-one years ago.

CONTRACTS AND CAPITAL

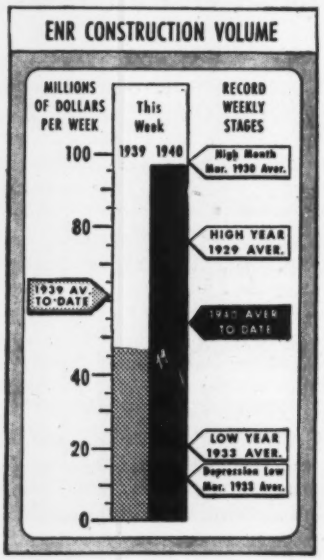
ENGINEERING CONSTRUCTION awards for the week, $96,286,000, turned up sharply and reached the highest level of the year. They topped the corresponding week last year by 107 per cent, and the preceding week by 70 per cent. Private and public construction both more than doubled their respective values for the 1939 week, gaining 113 and 103 per cent, in that order. Private work exceeded last week's volume by 30 per cent, and public was up 112 per cent.

The current week's volume brings 1940 construction to $1,354,747,000, a level 11 per cent below that of a year ago. Private awards for the 25-week period, $472,823,000, are up 24 per cent, while public construction, $881,924,000 is 23 per cent lower. Federal awards for the period total $210,679,000, up 46 per cent.

Six large industrial building projects in five states are primarily responsible for bringing this class of work to the highest volume since June 24, 1937. A $23,000,000 naval air base project at Corpus Christi, Tex., swelled the unclassified construction figure to its highest level since February 25, 1937. In addition to these classes of work, waterworks, commercial buildings, earthwork and drainage, and highways top their respective volumes for both last week and the 1939 week.

New capital for construction purposes for the week totals $6,871,000, a decrease of 7 per cent from the volume reported for the corresponding 1939 week. The week's financing is made up of $4,354,000 in state and municipal bonds, $1,948,000 in USHA loans, and $569,000 in corporate security issues.

New construction financing for the year to date, $617,744,000, is 32 per cent below the $907,687,000 reported for the 25-week period a year ago.



CONTRACTS

(Thousands of dollars)

	Week Ending June 22 1939	June 13 1940	June 20 1940
Federal	$5,827	$4,475	$35,930
State & Municipal	23,114	23,243	22,897
Total public....	$28,941	$27,718	$58,827
Total private...	17,602	28,923	37,459
TOTALS	$46,543	$56,641	$96,286
Cumulative 1940 .....(25 weeks)...			$1,354,747
1939 .....(25 weeks)...			$1,521,324

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	1939 25 Wks.	Cumulative 1940 25 Wks.
NON-FEDERAL ...	$596,260	$617,744
Corp. Securities..	125,015	88,718
State & Mun.....	312,500	434,998
R.E.A. loans.....	40,073	.....
U.S.H.A. loans...	116,226	87,204
R.F.C. loans.....	2,446	6,824
FEDERAL	$311,427	$.....
TOTAL CAPITAL..	$907,687	$617,744

FHA MORTGAGES

	Week Ending June 17 1939	June 8 1940	June 15 1940
Selected for appraisal $23,535		$28,166	$27,783*
Cumulative 1940 .....(24 weeks)....			$582,236*
1939 .....(24 weeks)....			$556,152

* Subject to revision.

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	June '40..	241.59	116.13
Building Cost	June '40..	201.65	109.00
Volume	May '40..	201	88

Parking Meters Held Illegal In North Carolina

Reversing a decision of a superior court, the North Carolina State Supreme Court June 8 ruled that parking meters are illegal in the state of North Carolina. The ruling was handed down in a test case brought by M. H. Rhodes, Inc., and Vehicular Parking, Limited, against the city of Raleigh, which had installed meters. It was pointed out that, although parking may be regulated, there is no statute in the state which permits a municipality to collect a fee for parking.

The court held that the authority to regulate parking does not mean that "any sort of restriction, whether appropriate or inappropriate, may be applied at discretion."

The meters installed at Raleigh were removed after the ruling.

• • •

New Highway Bill Now Before Senate

The 1940 highway bill was favorably reported to the Senate June 17 by the committee on postoffices and post roads. Total authorizations for the fiscal years 1942–43 are $160,500,000, or a cut of $18,000,000 under the bill as it passed the House. The chief cut is in grade-crossing elimination. Funds for the federal-aid system have been increased from $93,750,000 in the House bill to $100,000,000.

The entire section providing for loans to the states from the RFC for the purchase of right-of-way has been stricken out of the bill. This was to aid in building highways through metropolitan areas. The Senate probably will act on the bill this week, after which it will go to conference. The House conference committee is expected to insist on restoration of the loan feature.

Senate Increases Cost Limit On WPA Building Projects

In passing relief bill replaces old $50,000 restriction with $100,000 limit and eliminates cost to sponsors of defense projects

In passing the relief bill, the Senate imposed a $100,000 limit on building projects which may be undertaken by the WPA. Under present law there is a $50,000 limit on buildings; the House appropriations committee sought to apply this limit to all construction, but the House threw the limit out entirely. The matter will now have to be settled in conference.

The Senate version sets up a new classification of WPA project—defense projects certified to be such by the secretaries of war or navy. For these projects, the requirement that sponsors put up a quarter of the cost is eliminated, and $25,000,000 is earmarked for reduction of sponsors contributions on such projects. Neither will the limitations on hours and earnings of WPA workers apply to men employed on defense projects. Defense projects are exempted from the building size limit, and, in order to expedite defense projects, the amount which can be spent on administration of WPA is increased nearly $4,500,000 to total $43,720,000.

Another group of Senate changes would loosen up some of the restrictions imposed last year and by the House this year. The requirement that WPA workers be fired after 18 months is practically nullified by exempting all workers who have made a reasonable effort to obtain private employment. A House provision that single men be put on half time is made permissive by the Senate, and the prohibition on theatre projects is removed. Also knocked out is a House clause which would have dictated, month by month, the maximum number of relief workers to be employed.

California projects get priority

Among the first projects to be given priority under the plan to mobilize the WPA for defense work, as reported in these pages last week, are the following Army post jobs in California: rehabilitation of buildings, improving waterfront, sewers, waterlines, Fort McDowell, $1,109,000; at San Francisco Presidio, $175,000; temporary housing, grading, surfacing roads, improving buildings, fire breaks, drainage facilities at Forts Winfield Scott, Miley, Baker, Barry and Funston, $1,476,000; clearing underbrush, grading, buildings, tent platforms, $810,500; also hangar aprons, improving bridges, landing field, warehouses, buildings, roads at Hamilton Field. New freight and storage facilities, a quay wall extension, rehabilitation of buildings and a new ammunition depot, will also be provided at Mare Island Navy Yard at a cost of $525,000.

OPEN CUT EXCAVATION PLUS BACKFILL MAKES TUNNEL

To avoid a permanent open cut in a national military reservation, the California State Division of Highways, in constructing a 1,300-ft. tunnel as part of a new approach to the Golden Gate Bridge, built the roadway in open cut, constructed concrete portals and lining for a tunnel and then backfilled with sufficient excavated material to restore the previous ground level. Because the tunnel length is about the maximum that is feasible without artificial ventilation, a ventilating shaft 24-ft. square was provided and space has been left for putting in blower equipment if this should be found necessary. In and near the tunnel two 11-ft. lanes will be provided. An 18-in. center wall also will be constructed.

Included in the approach work, which consists of a 1½-mi. lateral connecting with the elevated main approach to the southern bridgehead to provide a more direct connection to western San Francisco, is construction of a curved concrete girder where connection is made with the existing elevated structure (*ENR*, Aug. 17, 1939, p. 217).

ENGINEERING NEWS-RECORD

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June 20, 1940

COST QUESTIONS are uppermost in every construction man's mind today. Recalling the rapid rise of materials and labor prices in the World War he is fearful of the future. Statistically no facts are available to allay these fears, but there seems to be general opinion among economists and government officials that only a gradual rise, and not a spiraling of prices, is on the horizon. Only available base for appraising the future is our knowledge of current and past costs, complete data on which are given in the special cost section of this issue.

Civil Works Reduction

PROPOSED REDUCTION of federal civil works is certain to involve many problems. Most of the public works scheduled for the coming fiscal year are in effect already under contract, or else, like federal-aid highways, they are obligated by agreements and commitments. In either case curtailment requires adjustments and threatens many dislocations of construction operations and employment. The difficulty is likely to be greater because civil works of defense value will probably not be curtailed and the total burden of cutting will therefore fall on non-defense works. Whether made by stoppage of work or by reduction of rate, there is no established provision for the cuts in either contract terms or government procedure that would inherently assure a square deal to contractor or workers. It may be hoped, therefore, that the problems involved will be studied in time so that equitable methods can be developed.

A Transit Age Ends

PUBLIC OPERATION of the two great privately operated rapid-transit systems in New York City, which began last week, inaugurates by far the largest municipal transit operation yet attempted in this country. Chicago, which during the week announced an operating plan for its new subway system, is likely to continue private operation. What the two dissimilar developments have in common is the abandonment of large sections of elevated line. This significant change marks the beginning of the end of a transit age—the era of the elevated railway. Since their origin three-quarters of a century ago elevated railways have built up great metropolitan areas, only to become obsolete. Loss of patronage to more modern forms of transportation is one factor. Blighting of the areas served has been another factor that caused a drop in passengers. Both of these changes could affect the subways that we are now building on the theory that they will forever serve us adequately; it is a challenging thought to city planners. But above all else the abandonment of the elevated lines is an expression of the popular will that rightly or wrongly maintains that the elevateds must go because of the dirt, darkness and noise that is associated with their immediate vicinity. The fact that the elevateds may have outlived their usefulness because of more basic causes or that they might be rehabilitated to rival modern subway service is not given a thought. The elevated railway is in the doghouse, and its extinction therefore is imminent.

Hidden Waterway Costs

THE PRESIDENT again has vetoed legislation that would have relieved the railroad companies and state highway departments of the full cost of bridge alterations called for by waterway improvements. Bridge owners would have been charged only that part of the cost that produced benefits to them such as reduced maintenance, the rest being charged against the waterway, where it logically belongs. Last year after Congress had adjourned the President vetoed a similar bill. This year he has done it again, despite the fact that Congress had passed the bill with little opposition. The present method of allocating costs is highly inequitable, particularly to the railways, who are forced to aid a competing form of transport, and the fact that it has been in effect for 34 years is no reason for keeping it in force as the President and his advisers in the War Department appear to believe. Its chief purpose is to help hide the real cost of building and maintaining the waterways. This method should be changed as one step toward making the waterways a self-supporting unit in our transportation system.

Negotiated Contracts

SLOWLY BUT SURELY the construction industry is being drawn into the preparedness effort. Although much of the planning is still shrouded in a puzzling secrecy, developments are beginning to appear that before long should reveal the pattern of the advance. The census of engineering firms and of designing and supervisory personnel is one of these. A marshaling of similar information on contractors and construction men, rumored to be imminent, will be another. Perhaps the most important and certainly the most pronounced development is the adoption of the negotiated contract for defense construction.

Although the negotiated contract is a cost-plus contract, the plus is a fixed fee based on the estimated cost and not a percentage based on the actual cost as was the case with the World War construction contracts which resulted in widespread inefficiency and considerable scandal. A more common term for the negotiated contract is the management contract, and as such it is extensively used on private construction. Its advantages for the government lie in the speed with which work can be gotten under way, in flexibility of handling changes in plans, in increased efficiency through being able to work with the contractor as a partner, and finally in reduced cost by eliminating the necessary contingent items in a competitive bid. To the contractor the negotiated agreement offers freedom from uncertainty of labor rates, material prices, weather and unforeseen difficulties. It also gives the contractor assurance of a profit.

Great credit is due the Bureau of Yards and Docks for pioneering in the application of this type of contract to public works. Given authority in May, 1939, to use it on naval airbase work outside the continental United States, the bureau worked out agreement procedures and later achieved unusual success with its operation in the field. Last month it issued a booklet which should be read by every contractor, entitled "Some Commentaries on Cost Plus a Fixed Fee Contracts" which is available from the Superintendent of Documents in Washington.

The new defense legislation extends the authority of both Army and Navy to use negotiated contracts in the continental United States. It thus is clear that the large majority of government contract work will be on this basis. Whether only the large contracting firms will benefit remains to be seen. However, as work increases in volume it seems reasonable that the smaller firms will get their chance, and even before that some of them no doubt will be given subcontracts by the large companies successful in getting negotiated jobs.

Without question such a contract is the proper instrument for the job at hand. Probably it cannot be justified in a democracy except in time of emergency, but when the score is eventually added up advantages may appear that can be applied to peacetime public works. It is a possibility worth keeping in mind.

Highway Subsidies

PUBLICATION of the voluminous report of the Federal Coordinator of Transportation on "Public Aids to Transportation" does much to clear the air in a highly contentious argument. Heretofore it has been impossible to determine what was fact and what fancy in the many statements that have been made by opposing forces over whether or not highway transportation is being subsidized with public funds. One may not agree with the conclusions of Eastman's staff [*ENR* April 18, p. 547, and May 23, p. 743], but at least we now have the basic facts and the pros and cons before us.

This stands out in the Eastman report: There can be no incontrovertible answer to the subsidy question. If highway transport is looked upon as a self-sustaining service in which those who do not own an automobile or a truck have no interest, then the motor vehicle users are being subsidized; but if we continue the long established policy of looking upon our streets and highways as community services then the question becomes one of determining what share of the cost of street and highway building and maintenance should be assessed against the general public and what against the vehicle operators. On this latter point, no fixed policy exists. Mr. Eastman's staff has determined what to it seems an equitable basis for cost allocation, and when that is used there exists no subsidy to motor transportation as a whole. In contrast is the study made for the Association of American Railroads by C. B. Breed, Clifford Older and W. S. Downs in which different assumptions produce a very large subsidy.

The findings of the Eastman staff need not be taken as the last word, but regardless of what percentages of total highway expenditures are taken finally as justly chargeable to the motor vehicle user, the total amount of motor vehicle taxes to be assessed against the user should be sufficient to meet these percentages of the total annual cost of building and maintaining our streets and highways.

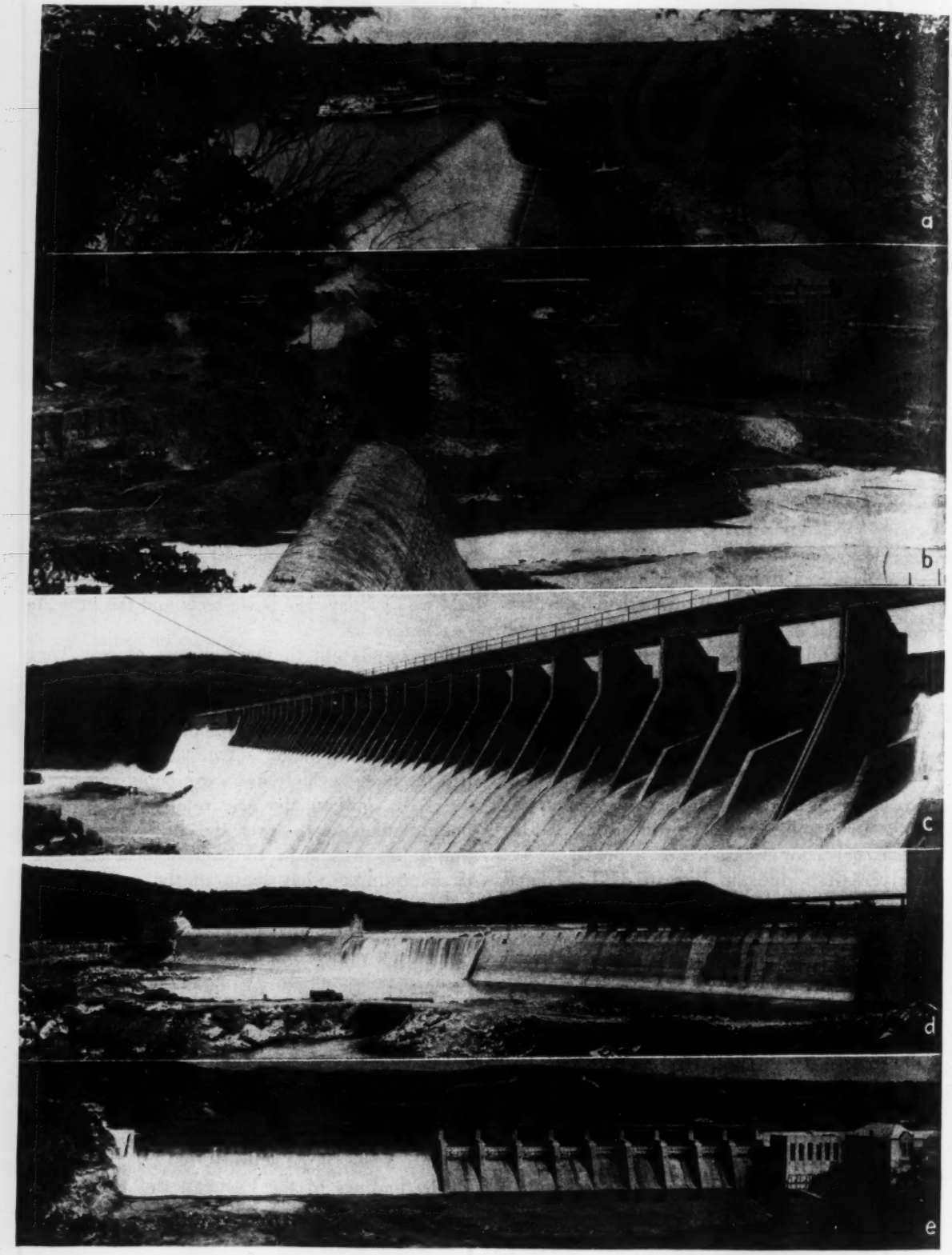


Fig. 1.

FIVE AGES OF THE AUSTIN DAM

(a) Original dam completed in 1893; (b) Ruins of the original dam which failed in 1900; (c) Ruined dam as reconstructed in 1915; (d) Rebuilt dam partly destroyed and put out of service in 1915; (e) New dam rebuilt from remnants of 1915 dam in 1940.

Historic Austin Dam Rebuilt

CLARENCE McDONOUGH
General Manager, Lower Colorado River Authority, Austin, Tex.

Contents in Brief—Fateful record over fifty years of the Austin dam is closed by rebuilding the old structure as the fourth dam of the lower Colorado River flood-control project. Permeable and erosive foundations contributing to previous failures were tightened by grouting; concrete apron and dam superstructure were reinforced and the floodway was increased.

THE DEDICATION OF THE AUSTIN DAM marks the close of a troublesome and fateful experience in dam building, as well as the completion of the major structures for power development and flood control on the lower Colorado River in Texas. As built in 1893 the Austin Dam was the largest concrete dam in the world. It failed in 1900. Eleven years later reconstruction was undertaken and completed in 1915. That same year floods caused a part failure, and piecemeal disintegration continued until the Lower Colorado River Authority took over the remnants and in 1938 began their reconstruction of it as the fourth dam of the Colorado River improvement. The page of views opposite show the five ages of the dam, alternating two periods of ruin and disuse with three periods of complete and useful structure. In 50 years Austin dam has been out of service due to accident for 40 years.

Choice of the old site of ill repute for the new dam was a logical one. The fact that a dam at this site is located below the storage reservoirs of Buchanan and Marshall Ford (*ENR* June 6, 1940 p. 63) made rebuilding practicable, as the regulated flow was adequate to produce sufficient power to pay the cost. Below this site, the river valley flattens out, a condition that would increase the cost of construction on a new site, and the geological conditions above the site are not improved over those existing beneath the old structure. Finally, proficiency in underground exploration and means of stabilizing faulty subsoils have greatly increased, and dam-building methods and tools have greatly improved. Of course, too, there were possibilities of salvaging a part of the old structure.

Salvage was large

The dam as it was taken over for reconstruction is shown by Fig. 1d. As shown, all of the gates and most of the gate structure that extended the full length of the dam were gone. Unshown, however, are extensive scour of the rock underneath and downstream from the dam toe. The explorations that disclosed these rock conditions and the stabilizing work carried out will be described in another article; this article deals primarily with the rebuilding of the superstructure.

In the rehabilitation of the Austin Dam, almost all of the existing structure shown in Fig. 1d was utilized. That part of the masonry dam on the left was transformed into a stable and satisfactory overflow gravity section, in accordance with the section Fig. 3a. Its height was raised 3 ft., making the total gross head for hydroelectric power development 62.8 ft. The profile of the original dam was cut back and keyed to give a bond for the downstream concrete reinforcing. Drains were provided at

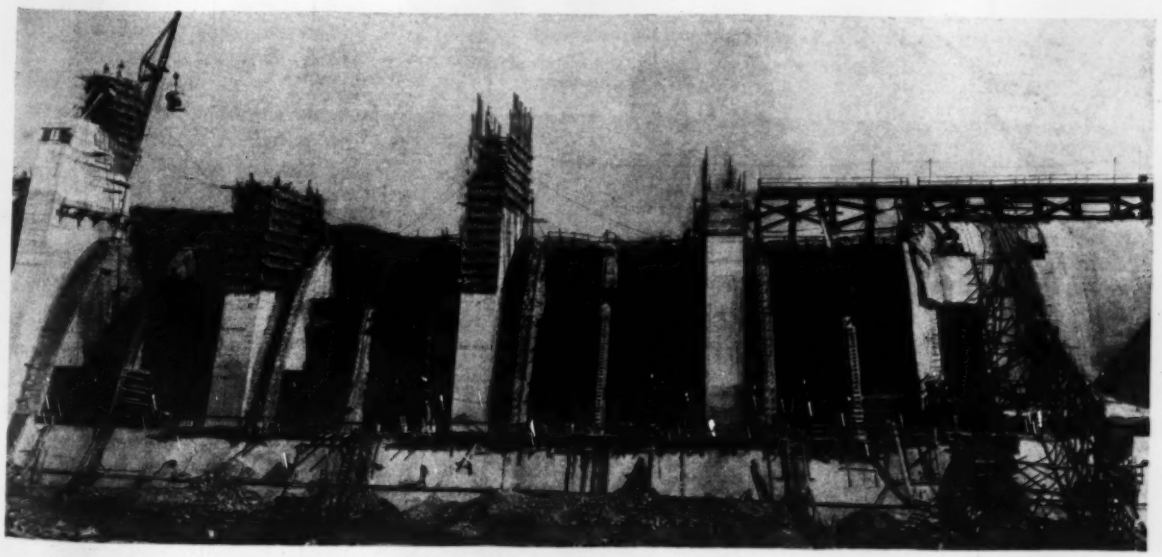


Fig. 2. **Rebuilding the hollow section of the Austin dam. Tainter gate pier construction is shown in this view.**

the joint between the masonry and concrete to prevent hydrostatic pressure from breaking the bond. Sufficient bonding to create an integral and monolithic action in the entire structure was obtained. The added concrete section is thoroughly keyed into the rock to prevent sliding.

The "broken-out" section or the left (west) portion of the hollow dam was restored in accordance with Fig. 3 b. The broken buttresses of the hollow dam (on 20-ft. centers) were connected to and spliced with a new downstream portion and supported against sliding. A new downstream deck was added, the upstream deck was strengthened, all buttresses were thoroughly underpinned and piers on 60-ft. centers and 9 ft. thick were constructed as outlined in Fig. 3b to support a battery of four 51x18-ft. Tainter gates. The rock surface downstream from this section was protected against future erosion with a thick concrete apron. In the analysis and design of this part of the dam, the large piers were assumed to support safely the hydrostatic thrust on the gates, while the dam was assumed to carry the silt and flood loads safely. A typical construction operation for this "broken-out" section is shown by Fig. 2.

The intact section or the right (east) portion of the hollow dam was rehabilitated in accordance with Fig. 3c. In this part the buttresses (on 20-ft. centers) were underpinned as well as supported against sliding, the upstream deck was strengthened and piers on 60-ft. centers and 9 ft. thick were built through the hollow dam to support a battery of five 51x12-ft. Tainter gates. As in the case of the "broken-out" section, a thick concrete apron was constructed to prevent future erosion of the rock downstream from the dam.

At the right (east) end of the hollow dam section a power intake and hydroelectric power plant has been constructed. A portion of the 1893 dam was utilized in the non-overflow gravity section through which the power penstocks are placed. Fig. 3d is a cross-section through this part of the dam. The hydroelectric power plant is completely new and is of compact and efficient design. It is of interest to note that the extremely high power house (110 ft.) was necessitated by the low setting of the hydraulic turbines as well as for the protection of the plant against high tailwater and for the accessibility of the station. This power structure houses two 10,000 bhp Newport News type of adjustable-blade propeller turbines.

From the power house sector of the dam eastward for 300 ft. an earth dike has been constructed. This earth dike utilizes the original headgate structures of 1893 and 1913 as core walls.

Foundation solidified

It will be noted from the drawings that a concrete cut-off wall has been constructed and extensive grouting

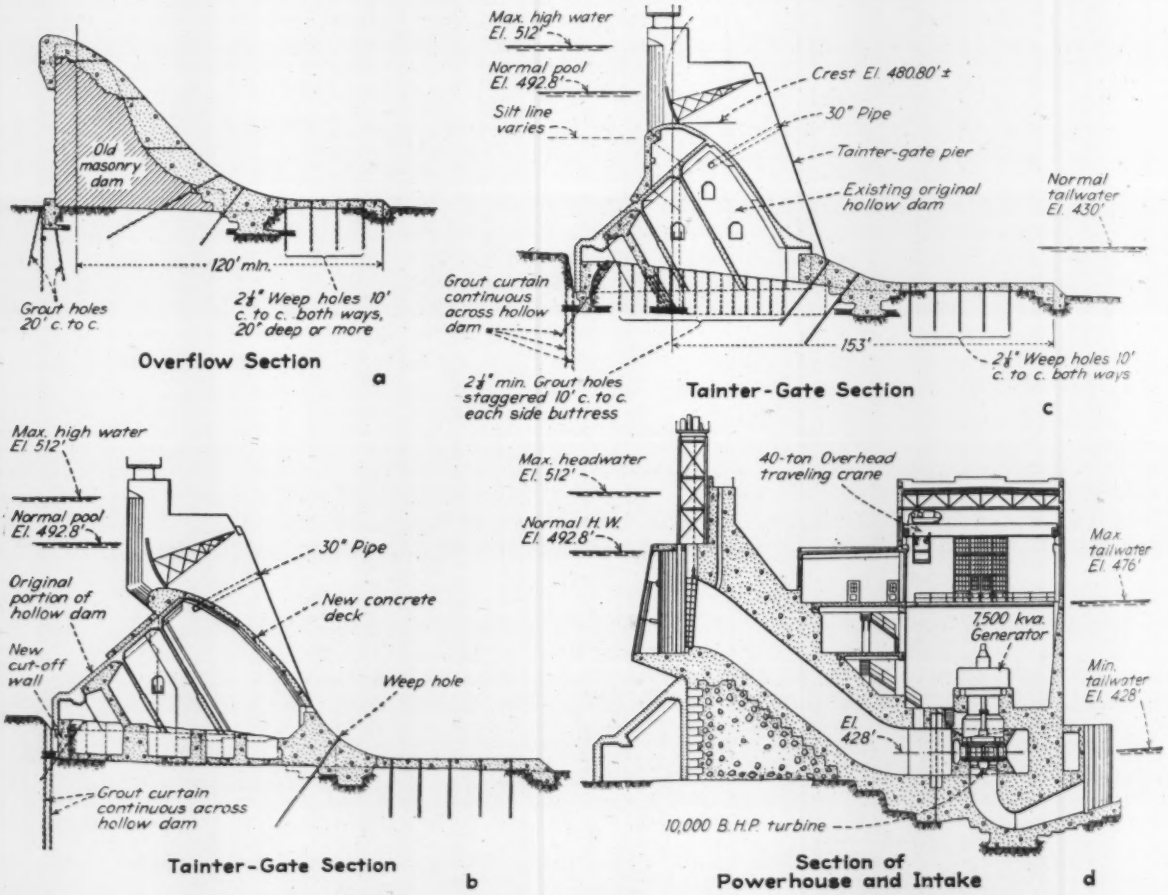


Fig. 3. Various methods were adopted for strengthening the foundations and reinforcing the superstructure of the Austin dam, depending on the nature and condition of the old structure.

has been performed along the upstream edge of the solid dam and hollow dam; also grouting has been performed along the core wall of the dike. This grouting and cut-off construction has helped render the dam foundation relatively impervious to the flow of water, a condition that formerly did not exist under the dam. No grouting was performed in 1893, and only shallow grouting was resorted to in 1915. A thorough subsurface exploration before the 1938-39 rehabilitation revealed that an extensive grouting program was necessary for the structure.

The view of the completed Austin Dam Fig. 1e shows, from left to right, the rebuilt overflow gravity section, rebuilt "broken-out" hollow section, rebuilt intact hollow section, and the power plant. By comparing Fig. 1e with Fig. 1d there can be noted the extensive improvements made to the superstructure of the dam, although the improvements to the foundation, which are more important to the successful rebuilding of the entire structure than the superstructure, are hidden. The total cost was $3,200,000.

All designing and all construction of the Austin Dam was performed by the forces of the Lower Colorado River Authority. Clarence McDonough as general manager supervised and directed all work, while O. L. Norman served as chief engineer, C. S. Adams as designing engineer, S. O. Miller as chief electrical engineer, and R. B. Alsop as superintendent of construction. The firm of Moran, Proctor, Freeman and Mueser were employed as consulting engineers throughout the exploration, designing and construction of the dam. George L. Freeman acted as the contact member for the engineers.

Timber Arches for Buildings

A. S. FRIEDMAN
Unit Structures, Inc., Peshtigo, Wis.

LOWER OVERALL DIMENSIONS possible through use of glued laminated timber roof arches have effected construction and maintenance economies in five highway equipment buildings recently completed by county highway departments in the state of Wisconsin.

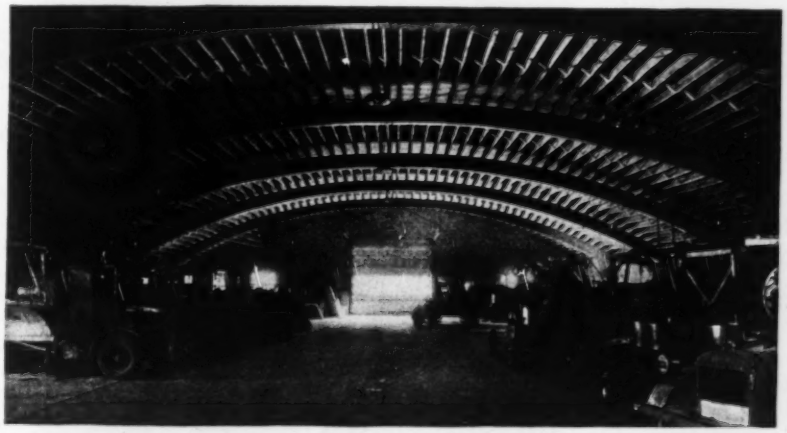
In all five of these buildings, reinforced concrete buttresses support glued laminated timber arches of uniform cross-section. In the usual building of the garage type, the required headroom of the center dictates the height of walls because walls must rise at least to the level of the roof truss bottom chord. By using an arch instead of a truss the center headroom can be maintained or even increased while the wall line clearance is reduced to the minimum desired. In this manner materials costs are reduced. Maintenance costs are likewise reduced because there is less volume to be heated during cold weather.

While the five buildings vary in details and some dimensions, the basic structural elements in each are the same. Reinforced concrete buttresses 9 ft. high support 80-ft.-span timber arches which are curved to one radius. Each arch is shop-fabricated in two sections which are connected during erection by ⅜-in. steel plates at the center. These sections, 7½x19½ in. in cross-section, are made up of 24 laminations of southern yellow pine. At the skewback the arches are bolted to shoes anchored in the buttresses. Each section is lifted into place by one-point suspension and all holes are drilled in the shop to speed erection. Arches are spaced 16 ft. on centers. On these, 2x10 joints are spaced at 16 in. and topped by 1-in. roof sheathing. Four one-inch-square rods laid in the floor concrete tie the buttress bases together.

Although sidewalls of the five structures are only 9 ft. high, doors are 16 ft. high and up to 24 ft. wide. Any piece of equipment, including a ¾-yd. shovel, can be stored against the wall so that it is possible to park or remove any piece without disturbing any other.

The five buildings are located at Sturgeon Bay, Green Bay, Merrill, Altoona and Oshkosh. The first three were constructed with the aid of PWA grants. Those at Sturgeon Bay and Green Bay are 80x100 ft. in plan, the former having walls of stone and concrete blocks and the latter of concrete blocks and face brick. The buildings at Merrill and Altoona are 80x160 ft., and walls are of reinforced concrete and of concrete block, respectively. The Altoona structure is the only one with parapet walls. The largest building is the one at Oshkosh. It is 80x200 and has a 25x96 wing in which are located a heating plant and a rest room for the workmen. This building has a brick exterior and haydite block backup.

The laminated timber arches were manufactured by Unit Structures, Inc., of which the author is vice-president.



Interior of highway garage at Sturgeon Bay, Wis., showing arch construction.

Piledriving Leads 135 Ft. Long

Contents in Brief—Specifications calling for piles 150 ft. long under a new postoffice building near the San Francisco waterfront made it necessary for the contractor to build a piledriver with leads 135 ft. long. By combining steel and wood in the leads the contractor obtained a driver that will have a high salvage value.

THE POST OFFICE DEPARTMENT required a new building near the San Francisco Ferry terminal and recently contracted for a structure at Mission and Spear streets, which is close to the Embarcadero. In gold-rush days this location was under the waters of San Francisco Bay, some 1,500 ft. from shore. It is part of an area that was filled in during the city's early development period. Like lower Market St., it is still slowly subsiding as the outer edge of the old fill pushes out toward deep water.

Foundation material at the new postal building site is soft black mud with occasional sand lenses. Because of the known tendency to subside and to push toward the bay, long piles were specified as is the custom for heavy buildings in this area. Based on tests, it was decided to use pile lengths ranging up to 150 ft. which, of course, required splicing. A total of 4,002 piles were required of which about 2,500 had to be spliced, thus bringing the total number of piles used to 6,500. Many of these were long; maximum single lengths ranged up to 126 ft.

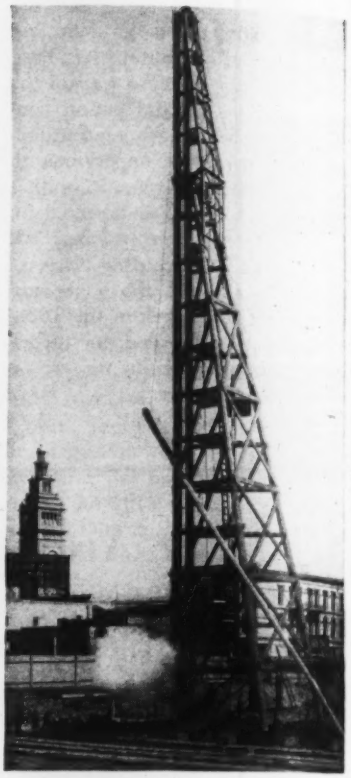
To handle the long piles, leads 135 ft. long were required, which meant building special equipment. To speed up the job two piledrivers were built with leads that would meet the special requirements. The method of constructing piledrivers commonly used on the West Coast is to frame and assemble the leads lying horizontally on the ground in front of the gunnels and then to raise the tower without the aid of a derrick or ginpole. Even with the addition of temporary bracing for the tipping-up process, erection in this way introduces bending stresses that approach a safe maximum in leads about 130 ft. long. It was considered impractical to frame and erect 135-ft. timber leads in this way. However, it was entirely possible thus to erect 100-ft. leads and then to add on as a unit, a 35-ft. extension. Placement of the steel was greatly facilitated by the use of a "floating ginpole" hoisted in the leads and held there while the steel topping was set.

The resultant drivers had the advantage that when this special job was completed the steel superstructure could be dismantled leaving 100-ft. leads well adapted to ordinary jobs.

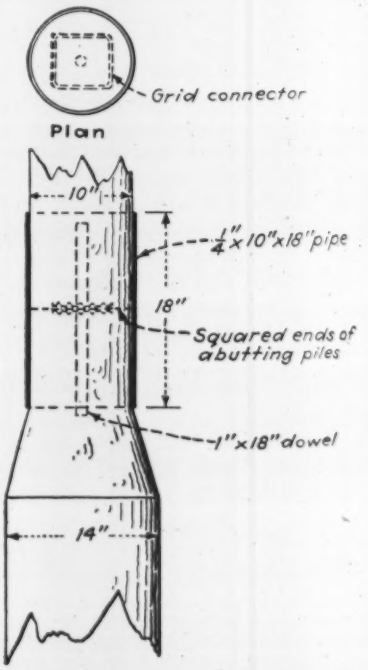
So rigid was the steel and wood combination that some of the long piles were picked up as much as 100 ft. to one side and were pulled into place by a line running to a sheave at the top of the 100-ft. leads. Ordinarily two lines were used in picking up a long pile; one line over the sheave of 135-ft. leads and one line through a block at the 100-ft. level.

By arranging for cooperation of the five largest producers of piles in the Northwest, an unprecedented rate of delivery to the job was maintained. This made it possible to get the 6,500 piles delivered and put down in less than four months. Some came by rail from the Willamette River in Oregon, and some from Puget Sound points by steamer. The longest piles came by rail and were loaded 30 piles to three flat cars. From the rail terminal and from the docks, piles were brought to the job on carrier blocks by overhead-type motor carriers. Tractors snaked the individual piles to within reach of a pickup line from each driver.

Before piledriving started, excavation was carried down about 12 ft. below street level. Driving started with the rows of piles along the outer sides of the excavation to check any



Piledriver with leads 135 ft. high consisting of a top 35-ft. structural steel section put in place as a unit after the timber portion had been erected. Ferry tower in background marks the waterfront.



Sketch showing method of making splice using steel pipe, dowel and connector grid.

tendency to push outward into the street and disturb utility lines. In the pile clusters under footings, the very close spacing made it desirable to first drive the piles around the perimeter of the cluster to prevent heaving. Although many of the piles were as much as 22 in. in diameter, and the 3-ft. spacing left only 14 in. between outer edges of the larger butts, yet no heaving occurred and excellent alignment was attained.

Specifications required the piles to have a minimum diameter of 7 in. at the lower tip. For piles whose lower tips were to go into splices, the minimum diameter was 10 in.

Splices were made by dressing down adjoining ends so that a steel pipe casing of 10-in. inside diameter would fit readily over both ends. A 1x18-in. steel dowel was driven half its length into the lower pile, using a drilled hole $\frac{15}{16}$ in. in diameter to give a hard-driving fit. Around the dowel was placed a 4-in. grid connector which would embed itself to equal depths in the two abutting ends when the squared faces came together. All pile tops were cut off square.

The job was done under the control of the Federal Works Agency, Public Buildings Administration, Geo. P. Hales, construction engineer. The special drivers were designed and built by the firm that held the piledriving contract, Ben C. Gerwick, Inc.

Self-Anchored I-Girder Suspension Bridge

C. H. GRONQUIST
Robinson and Steinman, Consulting Engineers, New York, N. Y.

Contents in Brief—Rolled beam stiffening girders and multiple twisted wire strands are combined to form a simple self-anchored suspension bridge. Its 20-ft. concrete-filled steel grid deck will carry traffic across the Wabash River south of Terre Haute, Ind.

FEATURED BY A 350-ft. main span, open strand cable construction and continuous girders, the two-lane bridge completed recently over the Wabash River at Hutsonville, Ill., is the fifth suspension bridge of the self-anchored type in the United States and the longest span in which single rolled beams have been employed as stiffening girders. Throughout their entire length the girders were erected 1 ft. above dead load position to facilitate connection of the suspenders, and were then lowered uniformly to introduce the dead load stress into the cables and girders. The bridge, 30 miles below Terre Haute, Ind., and the only crossing in the 60 miles between Terre Haute and Vincennes, will carry interstate traffic across the Wabash River.

A varying depth of sand which amounted to 75 ft. on the Indiana end of the suspended spans, dictated the use of a self-anchored in preference to an externally-anchored suspension structure. The 350-ft. main span is flanked by two 150-ft. suspended side spans and a 352-ft. continuous girder viaduct on the Indiana side to give an overall length of bridge of 1,002 ft. The design of the bridge does not permit provision for movement in the suspended span so all expansion in the 1,002-ft. length is taken in a single joint at the junction between the suspended spans and the viaduct.

The nearness of one end of the bridge to a town necessitated the use of a 5 per cent grade in the side spans and a corresponding parabolic camber in the main span to obtain an underclearance of 17 ft. above the 1913 high water and 42 ft. above mean low water at the center of the main span. The Indiana viaduct, the abutment for which is set in the river levee, is level except for the outer end where a vertical curve merges with the 5 per cent grade on the side span.

The bridge deck consists of a 20-ft. lightweight 4½-in. concrete filled steel grid roadway and two 2-ft. concrete walkways. Concrete for the floor was placed on plywood forms without the use of the customary galvanized steel pans. The steel floor is of typical framed-in stringer and floorbeam construction in 25-ft. panels and with the cables and stiffening girders placed 25 ft. apart. All steel in the bridge is structural carbon steel except the stiffening girders and floorbeams, where silicon steel is used.

The dead load on the suspended spans is 2,660 lb. per linear ft. of bridge in the main span and 2,860 lb. per linear ft. in the side spans. Floor members were designed for H-15 live loading while the stiffening girders and cables were designed for a total live load of 50 lb. per sq.ft. of roadway. The cables, which are stressed to about 67,000 lb. per sq.in. for dead plus live load, are made up of nine 1½-in. twisted wire strands, each of 270,000 lb. ultimate strength, arranged in open, square grouping. A single $1\frac{5}{8}$-in. wire rope forms the suspender which occurs at every floorbeam. Connection of suspender to girder was obtained by slotting the top flange of the girder and inserting vertical plates which were riveted to the girder web and to which the suspender socket was pinned. These plates were welded all around to both sides of the girder flange.

At the anchorage, that is the connection between the ends of the cable and the stiffening girders, the cable strand sockets bear through splay collars against the short leg of 8 x 2 x 1-in. angles riveted to the outer end of four 24-in. strand plates which are tied together by plates welded in the field after erection, and at the other end are pin-connected to a bracket in the bridge's stiffening girder.

This bracket occurs at the first panel point from the abutment to avoid complications in the detailing

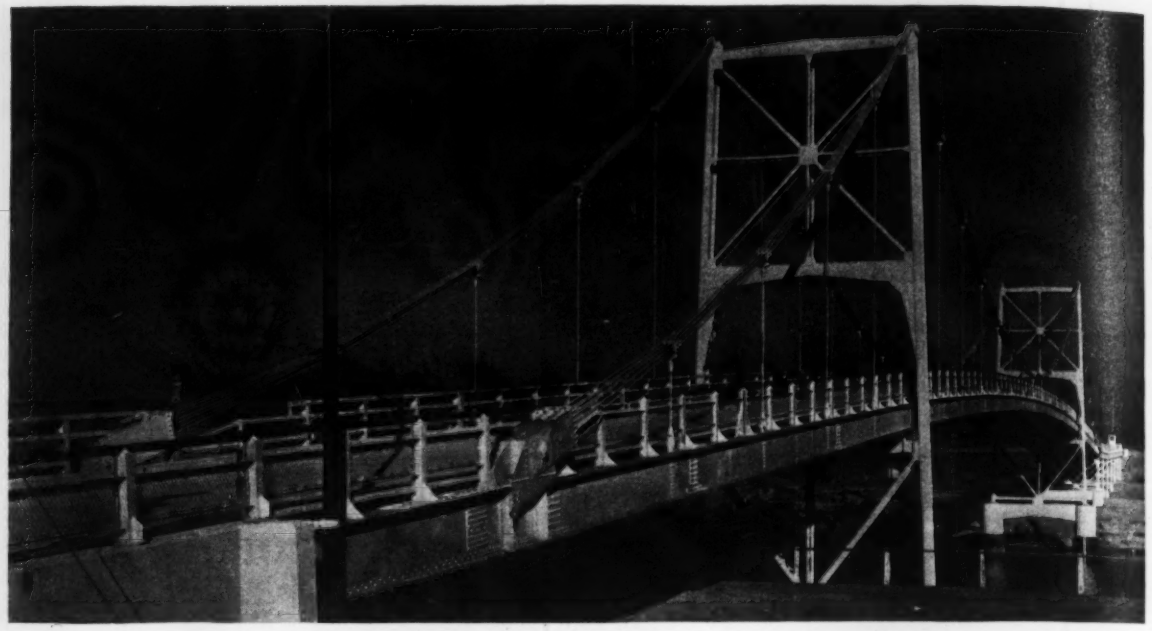


Fig. 1. Rolled beam stiffening girders and cables of twisted strands feature Wabash River self-anchored suspension bridge.

of the end of the stiffening girder other than that produced by the insertion of a deep web plate to form a part of the bracket and the building up of the first panel length of the stiffening girder. Anchorage of the cable to the girder at the first panel point subjects the end panel length to additional moment and shear produced by the upward component of the cable reaction. The girder was cambered downward $\frac{5}{8}$ in. in accordance with the dead load value of that moment.

In the side spans the silicon steel girders consist of 36-in. wide-flange 300-lb. and 280-lb. beams; in the main span 260-lb., 240-lb., and 230-lb. beams were used. The girder sections were in general 50 ft. long between milled splices designed to develop 100 per cent of the section of the smaller of the girders at the splice. Splices occurred five feet beyond panel points.

The 6 x 3½ x ⅜-in. angle laterals were designed to function as a tension system to take 2 per cent of the total dead plus live load direct thrust on the two girders. The capacity of the laterals so designed is more than sufficient to take the wind shear at the end of the main span, which, however, will be largely carried by the steel grid floor.

Rocker construction was employed for the main towers as well as the Indiana end bent. A 67-ft., 36-in. 182-lb. wide-flange beam forms the leg of the main tower, while two 14-ft., 18-in. channels are used in the end bent. Below the roadway all towers and bents are K-braced; above the roadway portal strut in the main tower the bracing is arranged in the form of the cross of St. George.

Fabrication and erection

The stiffening girder sections were fabricated in straight segments to the main span parabolic camber for dead load and with their lengths corrected for dead load shortening and difference between measuring temperature and the assumed normal temperature of 55 degrees F. Check of girder layout was obtained by measuring assemblies in the shop of half main span length.

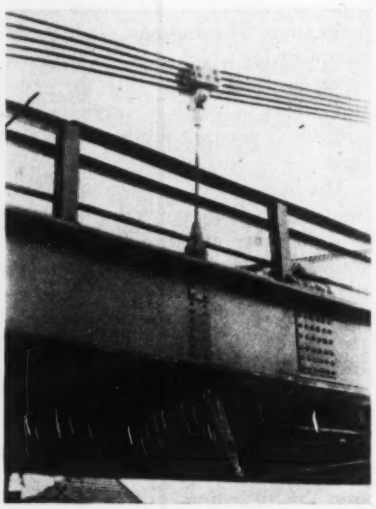


Fig. 2. 1⅝-in. suspender cable and fastenings.

The girders were erected on timber falsework bents supported on timber pile clusters set at an average of 50 ft. apart. Erection started at both ends of the suspended spans, and closure was made in the main span near the Indiana tower. All steel except the handrail was erected in one pass. The girders were set one foot above dead load position throughout their length, and their riveting was completed before they were lowered. Erection of the cable strands, on which tower positions had been marked at the time of measurement under full dead load stress, was accomplished with the use of timber gallows frames set on top of the towers. Following the erection and slight adjustment of the strands by placing steel shims between the sockets and the splay collars the cable bands and suspenders were placed.

Jacks for lowering the girders were placed at the towers, girder ends, and on intermediate bents in each span. Keeping the lashing which held the girders longitudinally at the Illinois or west abutment taut at all times, the south girder over its entire length was first lowered ½ in. at a time, a total of 2 in. The north girder was then similarly lowered a total of 4 in., and progressive lowering of both girders was carried out in the same way for the total 12 in. at the towers and girder ends. Pulling by use of turnbuckles was required to lower the girders at the towers and girder ends,

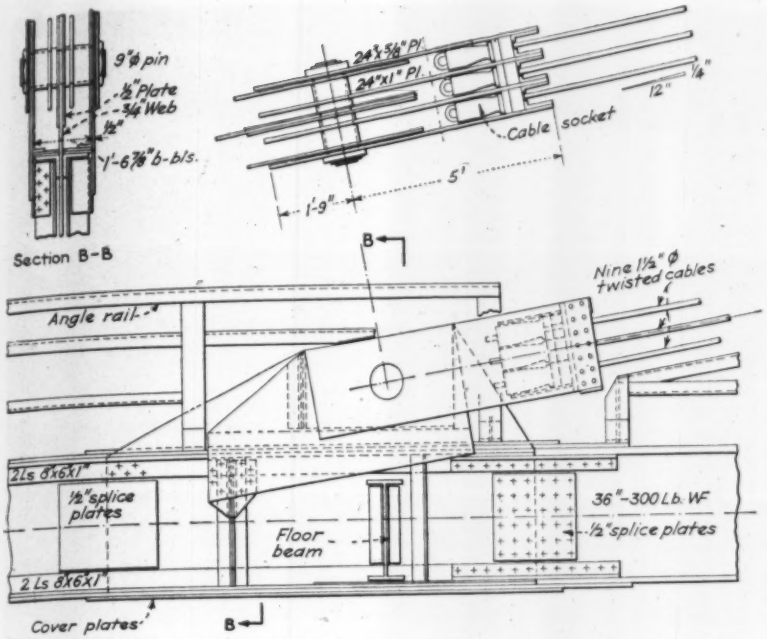


Fig. 3. Anchorage detail of the Wabash River Bridge showing the self-anchoring arrangement.

though the pulling at the towers was slight.

After the rocker pins had been driven and the spans swung, the 2-in. downward deflection of the side spans and the 18-in. upward deflection of the main span with respect to full dead load position were in good agreement with the computed values of these deflections. The placing and welding of the steel grid floor, followed by concreting, were done first in the side spans and last in the main span. Supports were used under the girders in the side spans, though that precaution was probably not necessary.

Main piers

The main piers each consist of two cylindrical shafts connected at the top by an arched concrete strut and set on square bases which were placed as seals within steel sheetpile cofferdams. The Illinois main pier bases were carried to shale; those of the Indiana main pier are supported on steel H-piles driven to shale. The Indiana end pier, which is similar in construction to the main pier, is also supported on steel H-piles driven to shale, while the Illinois abutment, well back from the river, is founded at a depth of 12 ft. in sand and fine gravel. This abutment, of unusually heavy construction, holds the entire suspended structure against longitudinal motion.

The Indiana viaduct consists of seven 50-ft. continuous girder spans in which the bottom flange of the 33-in., 125-lb. wide-flange beam girder is aligned with the bottom flange of the suspended span girder to preserve that line unbroken throughout the length of the bridge. The cross-section of the viaduct is identical with that of the suspended spans except for the difference in the depth of girders. Twelve inch steel H-piles driven to shale and K-braced above ground constitute the viaduct bents, which will bend with temperature expansion or contraction of the viaduct. At two of the bents near the outer end of the viaduct, where the temperature motion is considerable, slotted bronze plates on the girders permit a limited motion by sliding before bending the bents. The outer end of the viaduct girder slides on a bracket attached to the suspended span and bent.

Construction of the Sullivan-Hutsonville Bridge was commenced in January and was completed in December, 1939, at a cost of $200,000 as a toll project of Sullivan County, Ind. The general contractor was the Wisconsin Bridge and Iron Co. of Milwaukee, Wis., for whom Charles J. Glasgow of Detroit, Mich., was subcontractor on the construction of the floor and miscellaneous work. All steelwork was fabricated by the Vincennes Steel Corp. of Vincennes, Ind. The bridge was designed and its construction supervised by Robinson and Steinman, consulting engineers of New York, N. Y., for whom R. V. Milbank was resident engineer. The writer in general charge for the consulting engineers.

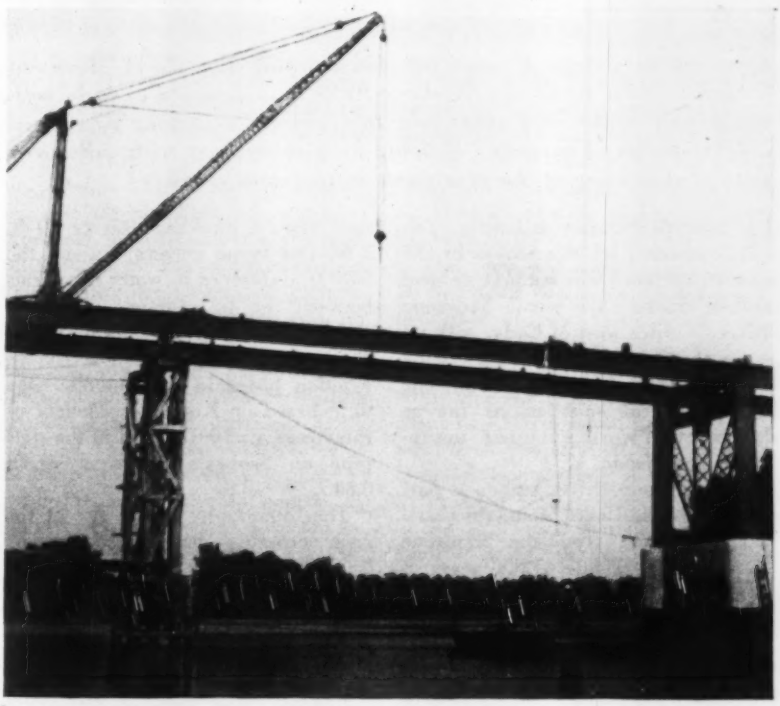


Fig. 4. Erection of closing section of stiffening girder. Falsework bents at 50-ft. centers supported structure during erection.

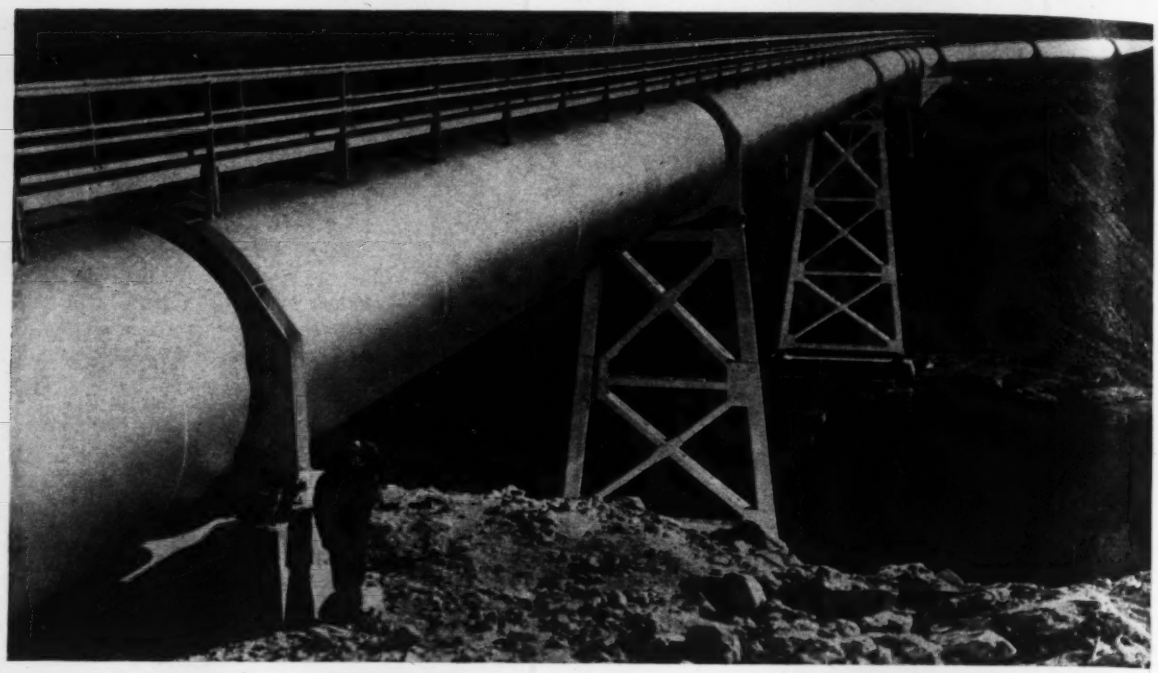


FIG. I. NO TRUSSES ARE USED TO CARRY THE SIPHON OVER THE RIVER, THE PIPE BEING SELF-SUPPORTING.

Siphon Self-Supporting in Long Spans

P. J. BIER
Engineer, U. S. Bureau of Reclamation,
Denver, Colo.

Contents in Brief—A large pipeline carrying the Heart Mountain irrigation canal across the Shoshone River is so designed as to be self-supporting in the long spans over the canyon. Stiffening rings used only at points of support. Welding used throughout with full X-ray control of welding at the pipe joints in the main spans

TOURISTS entering or leaving Yellowstone Park this season by the eastern entrance will see a large steel siphon crossing the scenic Shoshone River, 3 miles west of Cody, with no support other than thin towers rising from the edge of the canyon wall. The 150-ft. central span is, as far as known, the world's largest unsupported pipe span.

The Shoshone River siphon is part of the 28-mile Heart Mountain Canal carrying water from the Shoshone Reservoir to irrigate 41,000 acres of the Heart Mountain Division of the Shoshone Project which is now under construction in the northwestern section of Wyoming. It connects two concrete-lined tunnels and consists of 867 ft. of monolithically-placed concrete pipe and of 856 ft. of welded steel pipe. A pipe diameter of 10 ft. 3 in. was found necessary under the 6.89 ft. difference in water elevations between the two tunnel portals to carry the required 914 cfs of water. The maximum static head is 155 ft. Friction losses in the concrete pipe were based on Kutter's coefficient of roughness $n = 0.014$, and in the steel pipe on Scobey's coefficient, $K_s = 0.345$.

The topography of the site at the river crossing necessitated an extremely long central span across the river canyon. With recent advances made in the theoretical analysis of stresses in thin cylindrical shells and in the art of electric fusion welding, it was felt that a safe structure could be built with a span of 150 ft.

A plan and elevation of the siphon is given in Fig. 2. The bend in the steel pipe is protected with a heavy concrete anchor and the bend in the concrete pipe with a thrust block. The steel pipe is fixed in place by two other anchors, one in the form of a concrete encasement to provide a crossing for U. S. Highway 20 and one at the southerly end of the river crossing. Expansion joints were placed between these anchors to permit free temperature movements in the line between anchors.

The pipe is stiffened with double ring girders placed at the points of support. South of the crossing these ring girders are spaced a maximum of 40 ft. on centers. The load from the ring girders is carried to semi-steel rockers pinned to bronze-bushed bearings, which are supported on concrete piers. The supports for the river crossing consist of upper and lower rocker bearings which are pin-connected to a high structural-steel bent. These rocker bearings are of cast steel, and to provide free rocking

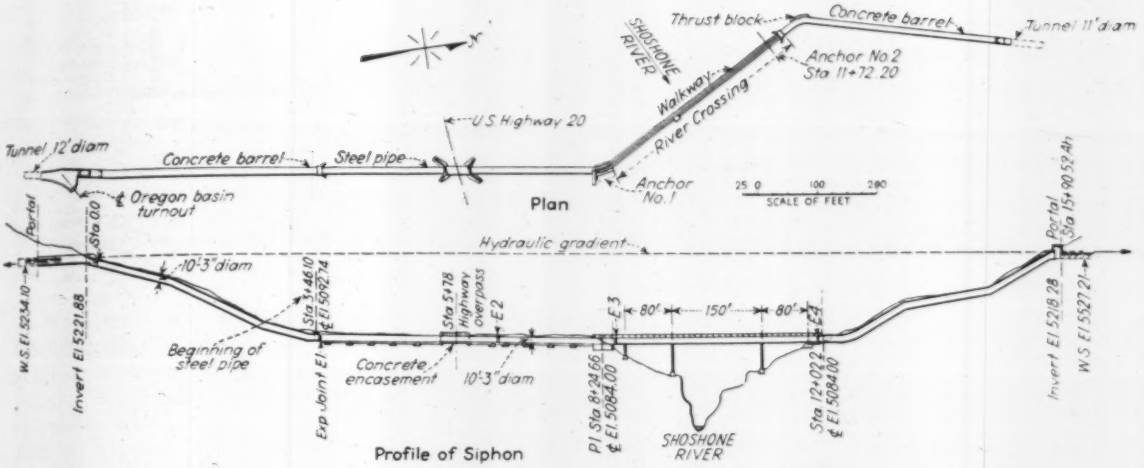


Fig. 2. The Shoshone siphon is made up of concrete and steel pipe and connects two tunnels in the 28-mile Heart Mountain Canal. The 150-ft. unsupported pipe span is said to be the world's longest.

movement, they are made in two halves, which are held together with steel collars. The purpose of the rocker supports is to reduce the longitudinal stresses due to the frictional resistance of the supports against temperature movement.

Statically the river crossing represents a continuous beam of variable cross-section, supported at four points and with short cantilever ends terminating in expansion joints. These expansion joints will permit vertical deflections in the line due to the elastic deformation of the supports without inducing additional bending moments in the pipe. The plate thicknesses were determined by limiting the equivalent stress (or combined lateral and axial stress) at any point of the pipe shell to one-half the yield point of the steel. The bending and shear deflection at the center of the 150-ft. span was computed at $1\frac{1}{2}$ in. with the pipe full of water. As it was desirable to have a level pipe when filled, a camber equal to the computed deflection was provided. No camber was provided for the 80-ft. spans, the deflection being small and hardly noticeable.

Ring girders

The ring girders act as rigid, disk-shaped members preventing undue distortions in the pipe shell at the points of support. The restraint placed upon the expansion of the shell at the ring girders when the pipe is under pressure results in high secondary bending stresses which are reduced to safe limits by an increased shell thickness adjacent to the ring girder support. The varying bending moments along the 150-ft. span required shell thicknesses of from $\frac{5}{8}$ in. at the points of contra-flexure, to $1\frac{5}{8}$ in. at the points of support. The minimum shell thickness in the remainder of the siphon is $\frac{7}{16}$ in. The ring girders were designed in accordance with the elastic theory of thin cylindrical shells as discussed in Herman Schorer's paper "Design of Large Pipe Lines" (*Transactions*, Am. Soc. C. E., Vol. 98, 1935, p. 101). Short support columns were welded to the ring girders a given distance from the centroidal axis of the ring section. The resultant eccentric connection serves as a resisting couple to counteract the heavy bending force in the ring girder. The ring girders were, in this case, designed for a condition of loading with the pipe just full, which, at this head, is also safe for the half-full condition. By properly proportioning the ring girders over the supports, intermediate stiffeners even for these long spans could be omitted. The ring girders and supports were designed for a condition of loading producing maximum stresses, which included a lateral earthquake force of 20 per cent of the vertical load.

The expansion joints connecting the river crossing spans with the remainder of the siphon are of a special double-acting type, permitting both longitudinal and lateral movements in a pipe length with respect to adjoining pipe sections. Such movements may be due to temperature changes, moment deflections or earthquake shocks. The joints have two stuffing boxes packed with five rings of long fiber, lubricated, braided flax. A large clearance between the pipe and the outer sleeve will permit sufficient lateral deflection in the line. The remainder of the expansion joints are of the usual single-stuffing-box type, which will permit only longitudinal movements in the pipe.

Shop fabrication

The pipe was fabricated from firebox quality steel plate, Grade B, A.S.T.M. designation: A 89–33. This material has a maximum carbon content of 0.22 per cent, which makes it especially suitable for welding, as the low carbon content reduces the tendency of air hardening, producing ductile welds. The minimum yield point of the steel is 27,000 lb.; the minimum tensile strength, 50,000 lb. per square inch and the elongation in 2 in. is from 25 to 33 per cent.

The pipe was shop-fabricated in 20-ft. lengths, which were made from two 10-ft. courses. The courses were rolled from one plate 120 in. wide.

All welding was done in accordance with the A.P.I.-A.S.M.E. code for fusion-welded, unfired pressure vessels. Both longitudinal and circumferential joints were of the double butt-welded type produced by the "Unionmelt" process under procedure control using automatic machines. For the pipe in the river crossing, all welded joints were radiographed, but for the remainder of the pipe only one radiograph was taken of each longitudinal and girth seam of each course. About 18 per cent of the radiographs for the shop welds showed defects, which were chipped

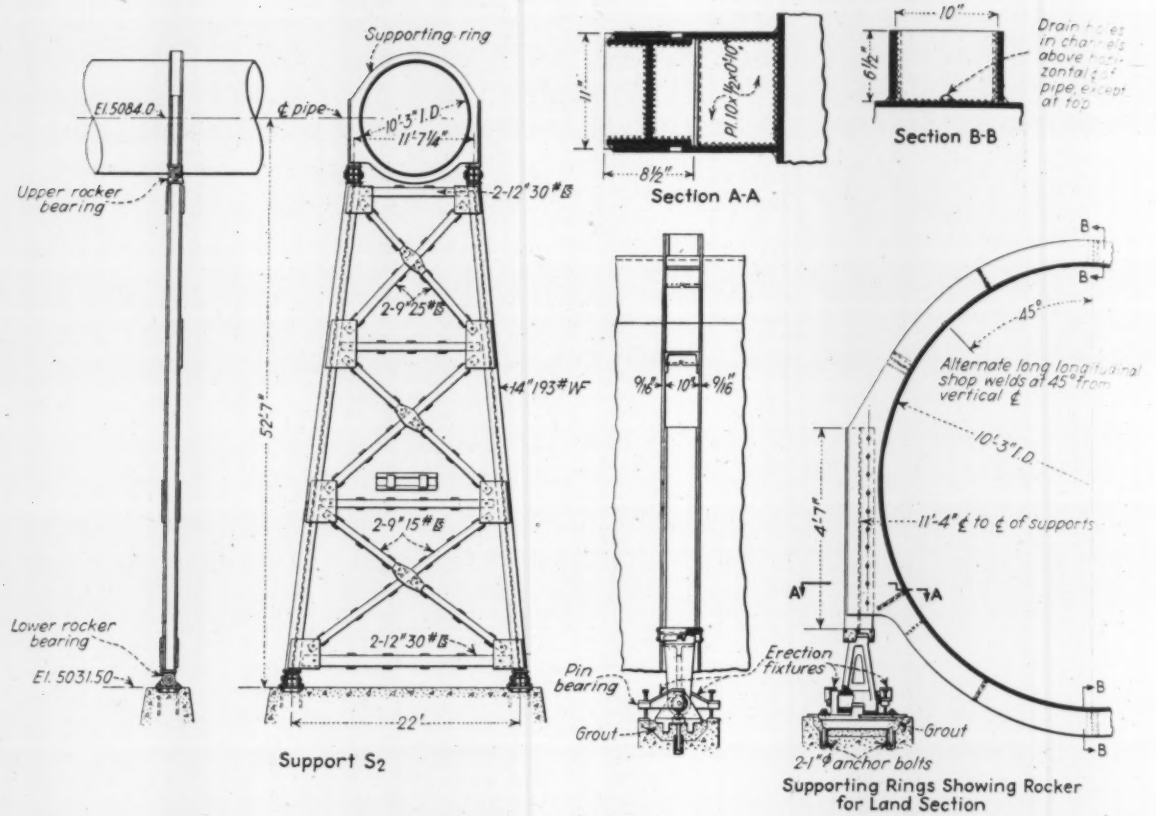


Fig. 3. Structural steel bents 47 ft. high, with rockers top and bottom, support the pipe at the sides of the canyon. Short rockers provide for movement on the land sections. Welding was used almost exclusively in assembling the structure, and extensive tests were made to assure the welding's quality.

out to sound metal, rewelded and re-radiographed. After completion of all weld repairs, the sections requiring ring girders were placed on a specially constructed jig where the ring girders and support columns were welded in place. All square-end pipe sections were then taken to a testing machine and subjected to a hydrostatic pressure test producing a hoop stress of 18,750 lb. per sq. in. The bend sections were tested by welding two bends together and attaching test heads on each end of the combined section.

After the completion of the hydrostatic pressure test, the pipes were grit-blasted with angular steel grit, after which they were painted with one coat of cold-application bituminous paint on the inside and one coat of red-lead paint on the outside.

Handling and erection

The pipe sections were shipped from the contractor's plant at Los Angeles to a railroad siding located 9 miles from the site of the siphon. The pipes were unloaded with a winch truck over a timber ramp and transported to a storage yard near the siphon with a special truck equipped with hydraulic rams which supported the pipe during the transport.

A timber trestle was erected across the river canyon to support the pipe of the river crossing spans during erection and provide a walkway for the erection crew. A track of 7-ft. gage was laid on the trestle over which the pipe sections were moved with a car, propelled with a dragline-operated cable. The pipe sections of the 150-ft. span were placed to predetermined elevations to obtain the desired camber at the center of the span, allowing for a slight reduction in camber due to weld shrinkage. The pipe sections in the two 80-ft. spans were welded completely before the sections of the 150-ft. span were

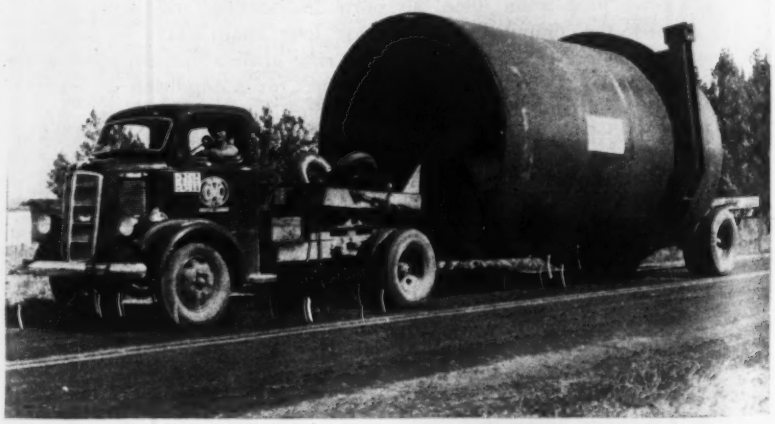


Fig. 4. Special hauling truck with hydraulic rams supporting pipe during transport.

welded. Welding in the long span proceeded from the ends toward the center of the span, checking the elevations at every joint. The welding of the closing joint at the center completed the span.

Practically all plates were grooved for inside welding which was preferable because of the cold winds prevailing at the site. After tack-welding, the first pass was applied at the root of the groove; then chipped clean of all slag, cracks or unsound metal. The remaining passes were chipped and peened, except the last pass. The bottom of the groove was then chipped to sound metal from the outside of the pipe and a finish pass applied which completed work on the joint.

Tests on the pipe

The radiographic examination showed good field welds requiring only 5.2 per cent of chipping and rewelding. A portable X-ray machine mounted on a rubber-tired chassis and equipped with a rotating device was used for the field radiographic work, which was all done from a position on the inside of the large pipe.

The rocker supports were set and grouted into the concrete piers in accordance with a temperature chart, which gave the proper spacing between rocker and rocker bearing for the temperature prevailing at the time of erection. The setting was generally done during the night, when the temperatures were more uniform at all points on the inside and outside of the pipe.

No leaks found

After completion of erection two dished test heads were welded into the pipe near the ends of the river crossing, and the pipe was pumped full of water. A test pressure of 137 lb. per square inch was applied and maintained for a thorough inspection of all welded joints. No leaks were found in the pipe and careful transit readings showed that the central span deflected to within $\frac{1}{16}$ in. of the horizontal under the water load, which proved the accuracy of the deflection computations and the camber setting.

Before the pipe was painted in the field it was thoroughly cleaned and all damaged areas in the shop coat were sandblasted and recoated by hand. The inside of the pipe was then given three coats of coal-tar pitch (C.T.P.-3), applied by brush, and the outside was painted one coat of red lead and two coats of aluminum with a varnish base. Construction work was started in March and completed in December, 1939. The total construction cost of the siphon was $271,000.

Contractors

The excavation and concrete work for the siphon were done by the Utah Construction Co. The steel pipe was fabricated by the Consolidated Steel Corp. of Los Angeles, and erected on a sub-contract by the Olson Manufacturing Co. of Boise, Idaho, with R. L. Glisson, field superintendent, in charge. Steel and welding inspection was under H. L. P. Stewart, engineer, and all construction work was directed by W. F. Kemp, construction engineer.

The concrete work was designed under the direction of A. B. Reeves, engineer, and H. R. McBirney, senior engineer in charge of the canal division. The principal design work for the steel pipe was done by F. Heidinger and M. E. Nantz, engineers, under the direction of the author. Steel siphon and penstock designs are under the general direction of W. C. Beatty, mechanical engineer, and L. N. McClellan, chief electrical engineer. All design work for the Bureau of Reclamation is under the general direction of J. L. Savage, chief designing engineer. R. F. Walter is chief engineer for the U. S. Bureau of Reclamation, and John C. Page, is commissioner, with headquarters in Washington, D. C.

Comparison of Mix Designs

N. M. FINKBINER, Engineer of Materials
G. W. HARRA, Asst. Engineer of Materials, Oregon State Highway Commission
O. A. WHITE, Research Technician

***Contents in Brief**—Studies by the Oregon State Highway Commission show that special concrete mixes of low cement content are apt to be uneconomic from the standpoint of work involved, that quality of cement has a marked effect on strength, and that sufficiently low water-cement ratios are difficult to obtain.*

VARIOUS METHODS of mix designs are proposed from time to time in current technical literature. Advocates of the different methods claim either economy, high strength, or both.

The work which is described in this article was undertaken by the Oregon State Highway Commission to obtain a comparison of a few of the proposed methods of design in mixes low in cement content. In every case but one it was necessary to use the high water-cement ratio of 1.08 in order to secure proper workability. In the one test where a lower water-cement ratio could be used, much higher strength was obtained. The variable which affected strength markedly was the quality of cement used.

Cylinders 8 x 16 in. were used throughout the commission's tests, instead of the usual 6 x 12-in. cylinders because the maximum size of the aggregate was 2½ in. All cylinders were broken at 28 days. In all series except A_1 and A_2 the fine aggregate was used as it was obtained from the pit. Representative samples were taken before every batch to insure constant grading.

Three methods of mix design were selected for this comparison as follows: (1) aggregate void; tests T_a, T_v, T_{a1}; (2) maximum density; A_1, A_2; (3) fineness factor (Oregon); A_3.

The aggregate void method is based on the theory that in any given concrete the mortar necessary is that required to fill the voids in the coarse aggregate, plus a small amount for workability and the cement paste necessary is that required to fill the voids in the fine aggregate plus a small amount for workability. The amount of excess paste and mortar

can be ascertained only by experimenting on the selected aggregates at the selected per cent voids.

The coarse aggregate was first segregated into three sizes: 3-in. to 1¼-in.; 1¼-in. to ¾-in.; and ¾-in. to ¼-in., segregated into three sizes: 3-in. to all screens having square openings. Forty-four combinations of these three sizes were made, and the per cent of voids taken on each combination. These values are plotted on the triaxial graph shown in Fig. 1.

The workability factor for mortar may be defined as the amount of paste (per cent of final volume) added to the fine aggregate above that necessary to fill the voids in the material measured dry loose. For these void aggregate designed mixes, 20 was taken as the workability factor for the mortars. The workability factor for concrete may be defined as the amount of mortar (per cent of final volume) added to the mixed gravel above that necessary to fill the voids in the material measured dry loose. Here also, 20 was taken as the workability factor for the concrete. In other words 0.8 cu. ft. of dry loose sand had all the voids filled with paste and enough additional paste added to bring the volume to 1 cu. ft. Likewise 0.8 cu. ft. of dry loose mixed gravel had all the voids filled with mortar and enough additional mortar added to bring the volume to 1 cu. ft.

The smallest per cent of voids in the gravel as seen on the triaxial graph, Fig. 1, was 34.8 (point *G*), but since point *G* represents a combination that would not be economical to produce, the combination producing 35.1 per cent voids was accepted as best suited to the aggregates from this particular source. Points *B* and *D* in the graph are the only combinations that actually produced 35.1 per cent voids; the remainder of the curve was approximated. Eighteen cylinders were cast of material combined as indicated at point *D*. To compare this combination with another on the same "iso-void", three cylinders were cast of material combined as indicated at point *E*. These series of tests were designated T_4 and T_5 respectively.

In order to investigate the difference in strength which could be directly attributed to a stronger cement, and to cement only, another series of nine cylinders was cast in which every detail was exactly the same as set T_4 except the brand of cement. This series, T_{41}, gave a 65 per cent increase over set T_4. This cement is also produced and marketed as standard portland cement.

Two sets of cylinders were cast to investigate the effect of maximum density of the aggregate on the compressive strength of concrete. Series A_1 consisted of thirty-six cylinders composed of coarse and fine aggregate screened to conform to the perfect grading curve for 2½ in. maximum size material. The percentages for each screen size were taken from a chart which had been figured from the commonly used maximum density formula $P=100\left(\frac{(d)^{\frac{1}{2}}}{D}\right)$ Series A_2 consisted of three cylinders made from the same proportion of aggregates as series A_1, except that a water-cement ratio of 0.9 was used instead of 1.08. This variation was possible because of the greater workability obtained in series A_1 due to the maximum density grading of the aggregate.

The mix for series A_3, comprising a set of eighteen cylinders, was set as paving concrete mixes are set in Oregon, where an additional restriction is placed on the coarse aggregate in that the material shall be produced in three sizes as follows:

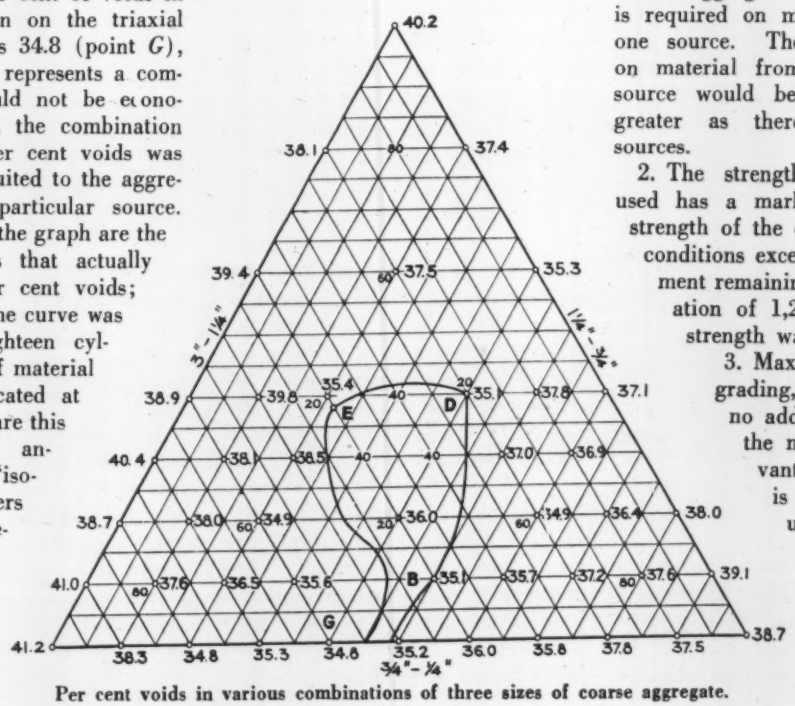
2½-in.	to	1½-in.	20 to 45 per cent
1½-in.	to	¾-in.	22 to 42 per cent
¾-in.	to	¼-in.	24 to 41 per cent

Another slight modification is made by interpolating for maximum size between the curves for fineness modulus and real mix found in the "Design and Control of Concrete Mixtures," second edition, published by the Portland Cement Association, January, 1927.

Table I gives the results of the tests on the series of mix designs.

TABLE I

Series	Slump	Yield	W/C Ratio	Compressive Strength Lb. per sq. in.
T_4 Void Aggregate, Point D	2-in.	1.05	1.08	1,837
T_5 Void Aggregate, Point E	2-in.	1.05	1.08	1,511
T_{41} Void Aggregate, Point D	1-in.	1.05	1.08	3,037
A_1 Maximum Density	8-in.	1.05	1.08	1,787
A_2 Maximum Density	½-in.	1.07	0.90	3,047
A_3 Fineness Factor (Ore.)	1-in.	1.05	1.08	2,093



Per cent voids in various combinations of three sizes of coarse aggregate.

Conclusions

1. The void aggregate method of designing concrete mixes requires a large amount of time and labor and does not give commensurate results. A large amount of time is consumed in obtaining the correct workability factor for the mortar, and again for the concrete, in addition to the time required to take many void tests on the different combinations of coarse aggregate sizes. This work is required on material from only one source. The work necessary on material from more than one source would be as many times greater as there were different sources.

2. The strength of the cement used has a marked effect on the strength of the concrete. With all conditions excepting brand of cement remaining constant, a variation of 1,200 per sq. in. in strength was obtained.

3. Maximum density grading, *per se*, produced no additional strength in the mix used. The advantage of this grading is that it permits the use of a lower water-cement ratio due to increased workability, resulting in a strength increase.

Sealing Oil-Mat Surfaces

D. L. CHENEY
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Helena, Mont.

BETTER WEARING and waterproofing qualities are being obtained on oil-mat roads by new sealing processes developed in 1939 by the Montana highway department. In Montana long distances and moderate road funds have necessitated an extensive development of oil-mat surfaces. (*Engineering News-Record*, Sept. 3, 1936, and April 28, 1938). During the last year two improvements in practice have been made that are sufficiently promising to deserve description. One is the use of armor-coat seals using heavy asphalts and stone chips and the other is oil-treating the entire roadway width including shoulders to prevent seepage into the shoulders.

During past seasons seal-coat work has been done almost exclusively with RC-1 naphtha cutback asphalt applied at a rate of from $\frac{1}{3}$ to $\frac{1}{2}$ gal. per sq.yd. Seal coatings of this type cost from $100 to $150 per mile, the average cost being about $120 per mile. On mats in which medium-curing or rapid-curing asphalts are used as binders, the RC-1 seals will usually wear off under normal traffic in from one to two years, necessitating re-sealing in most cases every other year.

Rain prevents curing

Much difficulty has also been experienced with this method of sealing during rainy weather. Under ideal weather conditions such as are experienced in this state through July and August, RC-1 naphtha cutback asphalt applied at the rate of $\frac{1}{3}$ gal. per sq.yd. or less, will cure in from 2 to 4 hr. When the weather is cooler, this curing period is much longer and if, after the asphaltic material has been applied, rain falls, it prevents curing, leaving a very slippery surface and an extreme traffic hazard. In connection with the oil-treating of roadway shoulders, the past two years have shown that many shoulder failures

Montana highway which has been built with new armor-coat seal and waterproofed shoulders.

are due to the seepage of moisture into the shoulder section of the state's roads.

Armor-coat seal

To provide a more permanent seal, eliminate traffic hazard, and toughen and increase the thickness of the wearing surface, the department has placed on all new construction during the past season a heavy armor-coat seal consisting of an application of $\frac{1}{3}$ gal. per sq.yd. of 95+ road oil, followed immediately by an application of 30 lb. per sq.yd. of crushed stone chips, meeting the following specifications: (1) passing $\frac{1}{2}$-in. square sieve 100 per cent, (2) passing 4-mesh square sieve, not more than 15 per cent, (3) retained on 10-mesh sieve, not less than 95 per cent, and (4) 75 per cent of the aggregate particles between the $\frac{1}{2}$-in. sieve and the 4-mesh shall show at least one fractured face.

The chips are rolled with heavy rollers into the hot 95+ road oil. This type sealing also gives a non-skid surface which is very desirable, particularly in this state where sleet, ice and snow conditions prevail during much of the year.

It is planned that all future construction will be designed with this type seal. Also, under the maintenance department, stone chips are being crushed for use on all surfaces constructed in the past where base and surface conditions justify placing a seal coat of this type. Costs of this sealing vary from $500 to $900 per mile.

To insure complete drainage of surface water, after the oiled mat has been placed and prior to placing the stone chips seal, the shoulders outside the oiled mat are swept free of all dust and foreign material, and if loose they are watered and rolled to secure adequate compaction. Following the sweeping, SC-2 road oil at the rate of approximately 0.3 gal. per sq.yd. is applied, and after this application has been permitted to cure, about 0.3 gal. of 95+ road oil is again applied. Immediately following the 95+ road oil, stone chips are applied at the rate of 30 lb. per sq.yd. and are rolled into the asphaltic material. The SC-2 and 95+ road oil are applied well out over the shoulder edges.

Edges rolled

At the time that the oiled mat is rolled, following the laydown, the mat edges are rolled down or beveled to a 6:1 slope. Therefore, after the shoulder treatment has been applied, there is a noticeable break between the edge of the oil mat and the beginning of the shoulder treatment, although it is not so abrupt as to create any hazard. To define definitely the traveled way, the treated shoulder section is given an application of $\frac{1}{4}$ gal. per sq.yd. of RC-1 naphtha cutback asphalt, following the chip application. This leaves the shoulders entirely black and the traveled way light in color.

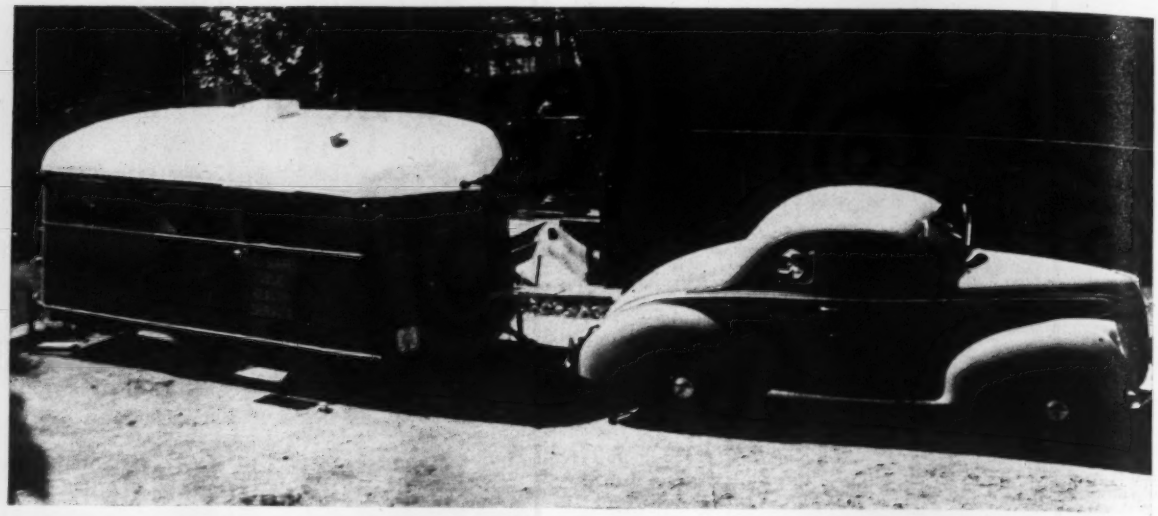

FIG. I. A LABORATORY ON WHEELS GOES TO WORK ON THE OHIO RIVER POLLUTION SURVEY

Mobile Laboratories for Land and Water

***Contents in Brief**—By using laboratories which can be taken directly to the samples to be treated, conventional practice has been reversed by the U. S. Public Health Service in studies on the Ohio River pollution survey. This article describes the trailer field units and the floating laboratory used in gathering stream pollution data in a drainage area of 204,000 square miles.*

MOBILE LABORATORIES developed for use on the Ohio River pollution survey are of special interest to the sanitary engineer. They were born of the necessity to provide means whereby laboratory facilities could be taken to the samples to be tested as contrasted to the usual procedure of bringing samples to the laboratory. In the Ohio River survey, which is now concerned among other things with the herculean task of gathering data on stream pollution conditions in an area of 204,000 square miles (*ENR*, May 23, 1940, p. 716) it was obviously impossible to provide laboratory facilities at all the points where information was needed. Neither was it practicable to work from only a few centrally located stations because of the distances involved and transportation time. The latter is of profound importance, since river water samples undergo changes and must be tested within a few hours after collection.

It was for these reasons that the U. S. Public Health Service developed mobile trailer laboratory units to reach tributary stream areas and, in addition, built a floating laboratory which could be moved up and down the Ohio River wherever tests were to be made.

Trailer field units

The idea of putting a laboratory on wheels is not new, of course. But the design and equipment of the units now in use on the Ohio River work include many novel features. In the first place, a unit consists of two elements—a trailer containing complete laboratory facilities, and a tow car. The latter is a dual-purpose accessory; it not only provides motive power for the trailer, but also serves as a means for quick collection of samples. Thus the laboratory can be located in the center of an area under study for a period of one or more weeks, during which the towing car collects samples within a 40 mile radius.

The general layout of the trailer unit is shown in Fig. 2. Specified details of the design and construction are as follows:

The unit is supported on a single axis, and has an overall length of 17 ft. 2 in., an outside width of 78 in., and a total height of 95 in. The centerline of the axle is so located as to provide a load space length along the floor of not less than 7.5 ft. between the front edge of the front wheel housing and the front of the trailer at its widest width. The vertical load on the drawbar for the trailer does not exceed 300 lb.

The trailer is mounted on a steel chassis to which is attached a double five-ply wood floor. The wall sections, which are also made of plywood $\frac{3}{16}$ in. thick, are covered on the outside with rustproof steel sheets. The roof is framed with spruce, covered with $\frac{3}{16}$ in. fir plywood over which there is a cover of No. 10 extra heavy waterproof canvas. Between the inside plywood walls and ceiling and the exterior covering there is a $1\frac{1}{2}$ in. space which is packed with spun glass for insulation against heat transmission. To provide ventilation in addition to that obtained from eight windows, an electric fan roof ventilator has been installed.

There are two electrical wiring systems. One of these operating from the 6 volt storage battery on the towing car, furnishes interior and running lights when the trailer is moving on the highway. The other system is designed to carry 110 volt alternating current, and is used when the trailer is parked. Connection with an outside source of current is made through a receptacle on the outside of the trailer into which a 150-ft. cable is plugged. The wiring system has been designed to carry a total load of 4,500 watts originating from the operation of light and laboratory equipment.

Water supply facilities

At the rear end of the trailer under a sink, a 30 gal. water storage tank was placed with an outside spout for filling, and a drain plug in the bottom. The tank is made of rust resistant material and has two baffle plates built into it to minimize water motion and swaying. In addition to the tank supply, provision is made at the rear of the trailer for a ¾-in. hose connection to city pressure. This water system was designed to operate without leaks at a pressure of 150 lb. per sq.in.

Over the housing of one wheel an icebox and sink unit of standard trailer design are installed. This unit has a 12x18 in. porcelain sink and an ice compartment having a capacity of 40 lb. of ice. In the sink is a double action water pump with copper suction lines leading to a water storage tank at the rear of the trailer.

The interior furnishings of the trailer, which were supplied by the contractor include: cabinets, cupboards, ice box and sink units, water tank and necessary piping, electrical wiring, receptacles and cable, a two burner gasoline stove, two one-quart fire extinguishers and a ventilating fan. Additional laboratory equipment provided by the Public Health Service include: one autoclave, one 20 deg. C incubator, one 37 deg. C incubator, one hot air sterilizer, and one electric hot plate.

The total cost of this mobile field laboratory including the tow car, equipment and six months' supplies was $3,671.

A detailed breakdown of the cost is as follows:

Trailer	$1,905.50
Tow car	649.13
Laboratory equipment	711.72
Glassware	231.90
Sampling equipment	47.00
Chemicals and supplies	80.00
Miscellaneous	45.75
Total	$3,671.00

Operating experiences

Commenting on the operation of the trailer units, the Public Health Service says:

"Both units left Cincinnati to undertake examination of stream samples on September 12, 1939. One unit operated in Ohio and West Virginia until December 6, 1939 when weather conditions made it undesirable to continue observations. The other unit operated in Kentucky until December 2, 1939, and from that date until the middle of March, 1940, it was located at Charleston, W. Va. for the purpose of carrying on a taste and odor survey of the Elk and Kanawha Rivers. This represents 2½ months of actual field work by one unit and 6 months experience with the other.

"Their operation has been quite satisfactory. The only difficulty worthy of mention occurred with 20 deg. incubators. These are special units provided with an electrical heating unit and mechanical refrigeration controlled by thermostats originally adjusted to maintain a temperature of 68 deg. F. within a range of ¼ deg. This adjustment was closer than practical, and by widening the range of ½ deg. the occasional troubles were overcome.

"Carrying a payload of something over 2,000 lb. it has been found best to carry a tire pressure of 45 lb. in the 7.50x15 in. trailer tires. Up to a speed of 40 mph the trailer units are easily handled, but at higher speeds a tendency for weaving develops."

Thus far the principal modification in original equipment has been the installation of electric heaters as a result of colder weather, and provision for the use of artificial daylight lamps to aid in making titrations.

Personnel of each unit consists of a junior chemist, a laboratory attendant and a chauffeur. The latter drives the tow car and trailer and acts as sample collector after the unit is on location. Plans and program of work and occasional field trips to each

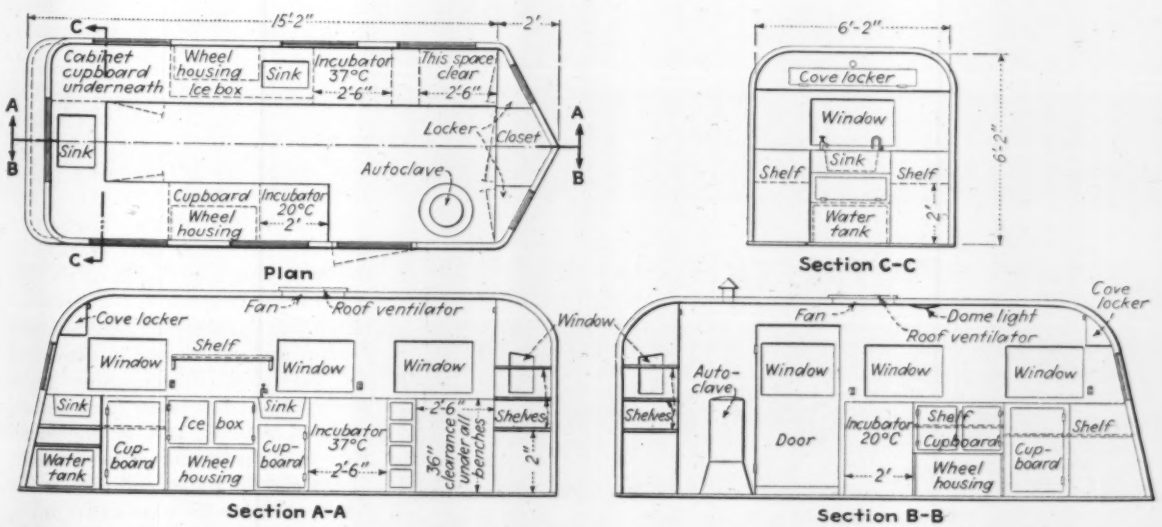

Fig. 2. Finding a place for everything was the designer's problem in laying out the laboratory on wheels. How well he succeeded in doing this and yet provided adequate working space in the trailer is clearly shown in this sketch.

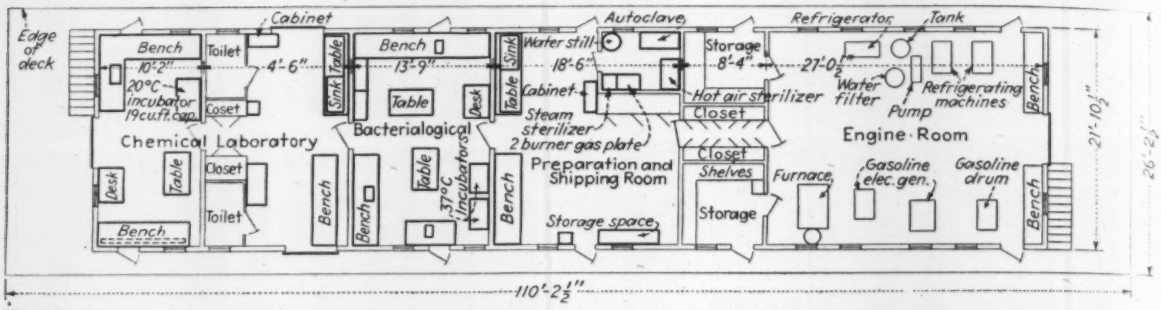

Fig. 3. General layout of the laboratory quarters on the main deck. On the deck above are living quarters for the personnel.

unit are carried on by the engineers of the Cincinnati office.

Based on the work done so far, the average daily capacity of each unit is 6 samples. On these samples the following determinations are made: temperature, at time of collection; pH; turbidity, mean probable number of coliform bacteria, total count on agar at 37 deg. c, 5-day B.O.D., dissolved oxygen and alkalinity. In addition the following tests are made on some of the samples: total hardness (soap method); iron; free acidity, and nitrites.

Floating laboratory

The floating laboratory which is operating on the Ohio River is an innovation in stream pollution studies. Never before have such complete facilities for analytical examination of river samples been incorporated in a mobile unit, as was done in this case by converting the Army Engineer quarterboat *Kiski* to laboratory requiremnets.

The boat is 107 ft. long and has a beam of 26 ft. It is provided with two decks, the upper one being devoted to living quarters and office space, and the lower deck serving as a laboratory workshop for the chemists, bacteriologists and sanitary engineers on board.

The layout of the boat and the major equipment with which it is provided are shown in Fig. 3. It will be noted that the lower deck is divided into four principal areas devoted, respectively, to a chemical laboratory, a bacteriological laboratory, a preparation and shipping room, and an engine room. The latter houses a central heat and power generating plant, and refrigerating machine. The upper deck contains 12 staterooms, a dining room, a kitchen and an office.

The personnel of the floating laboratory includes an assistant sanitary engineer, who is in charge of operations, a chemist, a bacteriologist, two laboratory assistants, and six additional men who are assigned to sampling and boat operation duties. Auxiliary floating equipment to the laboratory boat includes a 35-ft. motorboat, a yawl, and a fuel barge.

The Ohio River pollution survey is being made by the U. S. Corps of Engineers and the U. S. Public Health Service under the direction of the Ohio River Committee which is composed of Gen. T. M. Robins, Corps of Engineers; R. E. Tarbett, senior sanitary engineer, U. S. Public Health Service; and Abel Wolman, professor of sanitary engineering, The Johns Hopkins University.

Hydrometric work is being carried on by the Corps of Engineers under the general direction of Col. E. H. Marks, division engineer. Senior Sanitary Engineer H. R. Crohurst is liasion officer between the Corps of Engineers and the Public Health Service and he is in charge of the field surveys and engineering activities. The laboratory work is being carried on by the Stream Pollution Investigation Station at Cincinnati with Senior Sanitary Engineer H. K. Hoskins in general charge and Senior Sanitary Engineer H. W. Streeter in immediate charge.

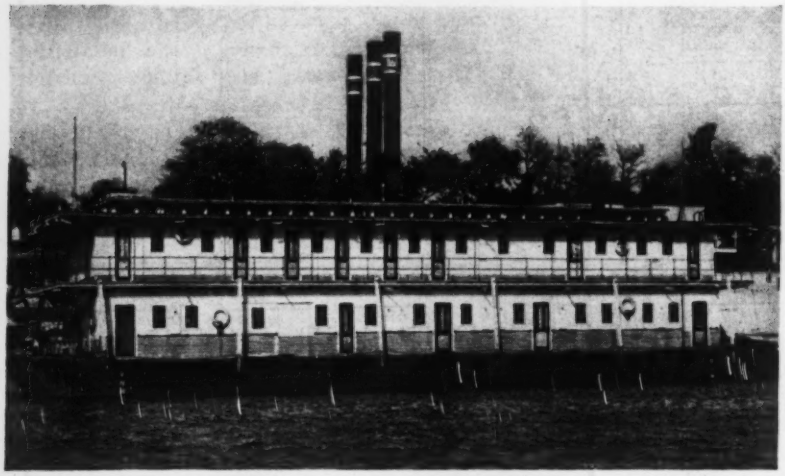

Fig. 4. It floats on the stuff it samples! The laboratory boat *Kiski* is an innovation in stream pollution survey operations.

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State Sanitary Control In Wisconsin

Developments in different lines of control of public sanitation in Wisconsin are noted in a recent report by L. F. Warrick, state sanitary engineer. Licensing of rendering plants became compulsory in January, and after conferences of the various parties concerned rules were adopted by the State Board of Health to provide for sanitary methods in the transportation and rendering of dead animals. Studies are in progress to determine the causes of objectionable tastes and odors in fish taken from certain polluted waters, and arrangements have been made with canners' associations and the paper and pulp industry to carry on the cooperative investigations of waste utilization or disposal and stream improvement.

Water Storage at Ashland Aids Treatment of River Supply

By J. P. BROWNSTEAD
Superintendent of Water Works, Ashland, Ky.

Contents in Brief—A raw water basin, holding ten days' supply, is used to even out variations in quality of Ohio River water, and thus reduce abnormally high treatment costs. An irregular shaped ravine was lined with concrete slabs to form the reservoir.

CONSTRUCTION of a 20,000,000-gal. raw water reservoir at Ashland, Ky., has just been completed as the first element in a waterworks improvement plan to insure better purification of the Ohio River supply to safeguard service during flood periods. The reservoir will hold ten days' supply, and thus furnishes an adequate reserve for use in case of the pumping plant being incapacitated by mechanical faults or flood conditions.

For the past decade the problem of operating the waterworks at Ashland has been one of the most difficult along the Ohio River. Evidencing the presence of heavy pollution in the river are the bacterial analyses, which show that the monthly average B. coli load has attained the maximum proportions of 65,000 per 100-cc sample; this is thirteen times greater than the maximum established by U. S. Treasury Department standards. In addition to this heavy bacterial load, the water contains many taste-producing substances resulting from industrial waste and algae. And, finally, the plant must contend with wide ranges of turbidity in the raw water. All this is reflected in the treatment costs which have amounted to as much as $28.50 per million gallons; the importance of this will be understood when it is stated that many water treatment plants operate with a chemical cost as low as $1.50 per mil. gal.

To assist in solving some of the difficult as well as economic problems involved in the purification of Ohio River water, the city has just completed construction of a large preliminary sedimentation basin. Among other things, this storage basin will serve as an equalizing tank for raw water, from which the treatment plant can draw a supply whose quality is more or less constant. Not only will the long storage period assist in the removal of settleable material, but it will provide an opportunity for flexible operation so that during periods when taste occurs or when the river is full of algae, pumping operations to the reservoir can be suspended and the entire supply drawn from the reservoir. The delivery of water of constant quality will likewise reduce chemical treatment costs.

The reservoir, built in a natural ravine and lined with concrete slabs, has a capacity in excess of 20 mg. This provides a ten-day storage period, based on present water consumption demand. One end of the ravine is closed off with a dam. The latter is an earthfill structure with a gravity concrete corewall anchored in rock for the most part; interlocking sheetpiling was employed to prevent leakage. The paving was poured in hexagonal-shaped slabs, 10 ft. to the side, with an average thickness of 5 in. As a large part of this basin is built on a bed of natural rock, the slabs were reinforced only in the filled areas. Hot expansion joint compound was poured in all joints.

Control of all draughts on the reservoir is accomplished through a reinforced concrete gate-house located just below the core wall in the maximum section of the dam. Raw and settled water are delivered to and taken from the reservoir through two 24-in. steel plate pipe.

Size and cost

The sedimentation basin was built with WPA financial aid and labor at a cost of $257,000. The project included 40,000 cu.yd. of excavation, 14,000 cu.yd. of earthfill in the dam, 190,000 sq.ft. of paving, 4,000 cu.yd. of concrete, and 8,000 ft. of 24-in. steel and cast iron pipe.

Other waterworks improvements now under construction include general rehabilitation of the purification plant, the installation of a new covered filtered water reservoir, and the installation of a 16-in. steel main interconnected with the distribution grid along the entire route; this reinforcing main is 9,200 ft. in length.

Alfred Le Feber, Cincinnati, is the consultant to the city on these projects, work on which is being carried out under the direction of the writer.

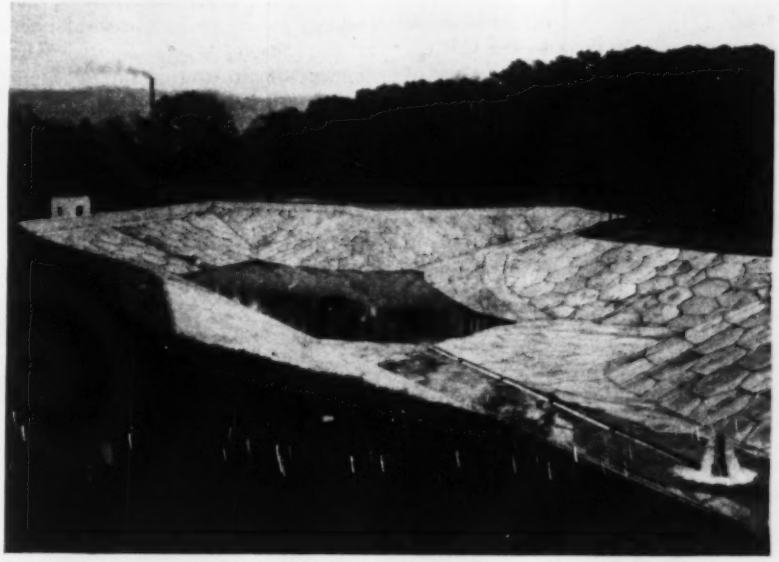


Fig. 1. A natural ravine closed with an earthfill dam and lined with concrete slab forms a 20-mg. water storage basin at Ashland. For cleaning the reservoir a roadway is provided, as shown at the right center.

Design of Pile Foundations Using Piles of Varied Lengths

HARRY E. ECKLES

Structural Designer, Holabird & Root, Architects, Chicago, Ill.

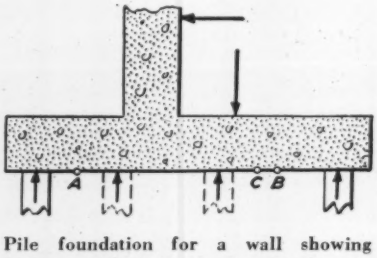
IN THE INTERESTS OF ECONOMY it is often desirable to use piles of different lengths and capacities in the same section of foundations. For these conditions, the common method of calculating the required bearing capacity for each pile by the moment of inertia method is substantially and fundamentally erroneous. The error lies in not considering the effect of differing lengths of piles on their settlement under loads. Reference is not made here to the effect of uncertain bearing resistance of piles.

The conception underlying the moment of inertia method for pile foundations is similar to that for resisting moment in the cross-section of a beam. This conception is proper only for footings on soils or on piles of uniform spacing and length throughout. The resistance under the footing is then somewhat analogous to that of homogeneous materials in the cross-section of a beam, the fibers of which are spaced uniformly and have inherent equal resisting *capacity*. For both of these wall conditions, the footing will not be horizontal when subject to the design loads if the resultant of the loads is eccentric with respect to the footing. In the case of the common type of pile foundations for walls, equal inherent resisting capacity does not exist for each unit of area of the whole footing, as is the case for the cross-section of a beam of homogeneous material. It is also important to notice that in this type of wall the footing comes to rest in a horizontal position when subject to the design loads.

Economical method

In the common type of pile foundations for retaining walls, or other walls with eccentric loading, the piles are often not of uniform length and spacing, but are designed to have the same resistance per foot of length of all piles. That the footings are then horizontal under design loading is seen by considering that in practice foundation piles will have a length proportional to their required load. Where piles are driven in homogeneous material, experience shows that this practice is reasonable. In designing foundations, the total settlement of short piles may therefore be considered equal to the total settlement of adjacent longer piles, if the length of each pile is proportional to its required capacity. Footings on foundations of this type will then be horizontal in their final position. Equal settlement of the tops of all piles in such foundations is in contradistinction to the unequal change in length of the fibers under stress in the cross-section of a beam, where the moment of inertia method of design is used. A different method of determining the required capacity of piles in economically designed foundations should therefore be used instead of the usual moment of inertia method.

The simplest method of design of pile foundations is that for walls which require only a longitudinal row of piles under each side of the footing, as shown by the solid lines in the accompanying figure. The moment of all external forces acting on the wall may then be taken about the center line of either row of piles. This will give directly the total load on the other row for any given length of wall. Settlement of all piles will be the same and the footing will be horizontal, if the length of the piles in each row is made proportional to the load which is required.



Pile foundation for a wall showing points at which moments are taken in determining loads on pile groups.

Where there are three or four longitudinal rows of piles under a footing, a simple and accurate method of design is to group adjacent longitudinal rows in two pairs where there are four rows of piles, or in one pair and a single outside row where there are only three rows. For these cases the capacity of all piles in any pair of rows may conveniently and correctly be considered equal. A trial transverse spacing of the rows must first be assumed for all cases, but it will generally not be necessary to assume the longitudinal spacing in advance.

For the case of three longitudinal rows of piles, the moment of all external forces may be taken about the single outside row, in the same way as given for the case of only two rows. This will give directly the total load on the group of two adjacent rows of piles for any given length of wall, and the half of this total will be the load on each row of the group. The total load on the single row of piles will be the total vertical load on the wall minus the total load found for the pair of rows. The longitudinal spacing for all rows can be determined after the computations are made for the total load on each row, and will be determined by the capacity of piles used. Since all pile capacities in the group of two rows will be the same, the length and longitudinal spacing of piles must also be the same in both rows.

For footings with four rows of piles, the required pile capacities may be computed accurately by considering the two adjacent rows at one side as in one group, and the two other adjacent rows in another group. The moment of all external forces for a given length of wall may then be taken about a point at *A* or *B* in the figure, located half way between the rows of the group, in accordance with the method used to determine the reactions of a beam with supports at *A* and *B*. This will give directly the total load on the two rows of the other group of piles. The capacity and longitudinal spacing of the piles in both groups is then determined by the method given before.

The moment of external forces may also be taken about any point in a group of piles, if the relative capac-

ity and longitudinal spacing of the piles in the group are afterwards made so as to bring the center of gravity of the piles of the group to the same point about which the moment of the external forces was taken. For example, the total capacity of piles in the rear row of a retaining wall may be assumed as half of that in the adjacent row, and the longitudinal spacing assumed to be the same in both rows but not fixed in value in advance. The center of gravity and point about which the moment must be taken is then at *C*, which is at a distance from the rear row equal to two-thirds of the assumed distance between the rows. This flexible method of design sometimes permits using more convenient capacities or spacing of piles in any group and row.

Grouping piles

For the case of walls requiring five or six longitudinal rows of piles, the rows may be combined in groups of three and two for walls requiring five rows, and groups of three and three for walls requiring six rows. The same method of design is then used for these cases as given for the previous ones. If it is desired to do so, the center of gravity of any group of piles may be determined in advance by assuming only the ratios of the pile capacities and transverse spacing of rows in the group. The longitudinal spacing for each row can be determined after dividing the total load for the group by the sum of the ratios of the capacities for the group. This division will give directly the total required capacity for the row having the maximum capacity, provided the total relative capacity for this row is assumed at the first as unity and the others as less than unity. The required capacities for the other rows are determined by their proportion to unity.

The principle of least work may be used to prove the correctness of the simpler trial and error method of design given herein. This method gives results such that the center of gravity of the computed pile capacities corresponds to the center of gravity of the external forces. The method as given for retaining walls is also applicable to most other types of pile foundations which have loads applied eccentrically, such as the foundations of external walls of buildings and of dams.

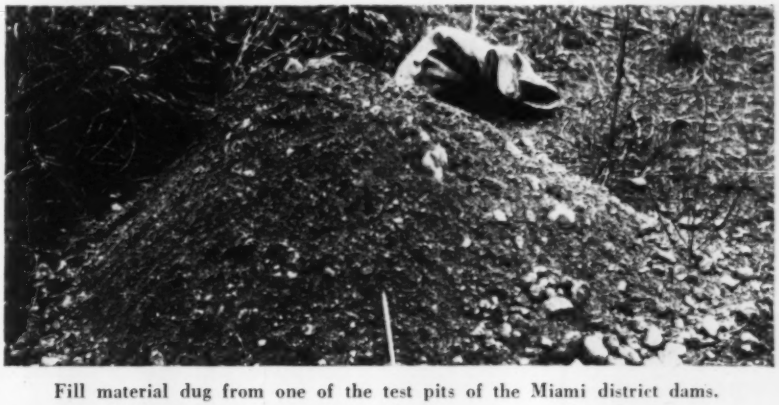
Shell Material in Dams Of Miami Conservancy District

C. H. EIFFERT
Chief Engineer, Miami Conservancy District, Dayton, Ohio

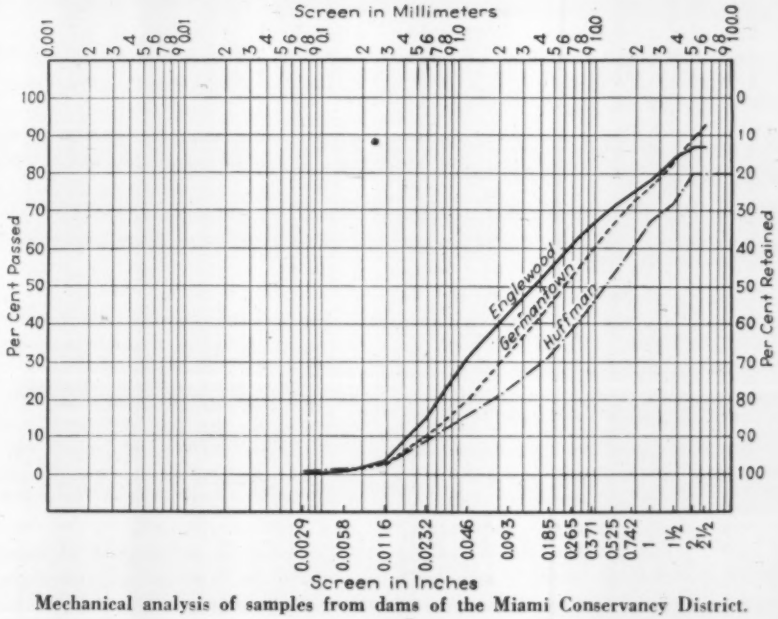
SOME TIME AGO in connection with a discussion of material for the outer section of hydraulic fill dams the question arose as to the nature of this material in the dams of the Miami Conservancy District. While many analyses of core materials had been made, there were none available of the sand and gravel in the outer sections of the dams. (Construction of these dams was described in *ENR* Sept. 9, 1920, p. 486; Sept. 16, p. 547; and Sept. 23, p. 600.)

Samples were taken from the Englewood, Germantown and Huffman dams and mechanical analyses made. Three samples were taken from each dam at depths of one to three feet. The surface material was discarded as it contained considerable humus resulting from the vegetation on the slopes. Each sample screened consisted of 200 ounces of material.

Results are shown in the diagram, the graph for each dam representing the average of the three samples taken. The photograph shows the material as dug from one of the pits.



Fill material dug from one of the test pits of the Miami district dams.



Mechanical analysis of samples from dams of the Miami Conservancy District.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

An Aid to Estimating

THE BUILDING ESTIMATOR'S REFERENCE BOOK and VEST POCKET ESTIMATOR—9th Edition. By Frank R. Walker. 1,701 pp. Published by Frank R. Walker Co., Chicago, Ill. Price $10.

This ninth edition marks the 25th year of this reference work. It has been rather fully revised and contains information on modern equipment and new materials. In some cases obsolete paragraphs remain to remind the machine age of horse-and-wagon days, but added paragraphs describe mechanical replacements. The book describes construction operations and gives actual labor requirements with spaces for local wage inserts to determine approximate building costs. Liability and compensation insurance is covered with data for each classification in every state.

Soil Mechanics

SOIL MECHANICS AND FOUNDATIONS—By Fred L. Plummer and Stanley M. Dore, 473 pp. Published by the Pitman Publishing Corp., New York. Price $4.50.

626.73 P73

As stated in the preface of this book, "Significant advances have been made in our understanding of the performance of soils used for engineering purposes. This book represents an attempt to correlate, summarize and simplify these developments for the benefit of those who have not had an opportunity to specialize in this field and those who are just beginning to study such problems. It is not intended for research workers but rather for engineers and students who wish to become familiar with the basic principles and the methods of application to engineering problems." Thus the book attempts to fulfill a double purpose as a text book and a source book.

The chapters of the book dealing with seepage of water, permeability, ground water and unwatering of foundations are excellent and evidently drawn from the wide experience of one of the authors, as are also the chapters dealing with earth dams likewise drawn from one of the authors wide experience. These chapters constitute quite a portion of the book, so that the remainder on soil mechanics proper is rather restricted.

The book bears evidence of an extensive research in libraries for the latest theories and applications of soil mechanics with the result that several difficult and often rather incomplete mathematical analyses and formulæ are presented to those who, in the words of the preface, are "just beginning to study such problems." It may be argued that "soil mechanics" cannot be divorced from the higher mathematics and therefore we have to endure its difficulties in order to share in its benefits. The reviewer however is not without hope that soil mechanics may be rescued from the mathematician and restored to the engineer and discussed in terms any wide awake engineer may understand.

As far as foundations are concerned, except for the foundations of dams, particularly earth dams, the subject is very sketchily covered.—*Reviewed by* LAZARUS WHITE, *Consulting Engineer, New York.*

Engineering Foundation

TWENTY-FIVE YEARS OF SERVICE, 1914-1939—Report of the Engineering Foundation, 33 W. 39th St., New York City.

Much of the present intense activity in engineering research had its origin within the past quarter century, since the establishment of the Engineering Foundation by Ambrose Swasey. A summary of the 25 years of activity of the foundation, prepared by Otis E. Hovey, director, gives a broad survey of the many lines of research in which the foundation participated by financial and organizing aid, and reflects typically the range of inquiry which modern engineering research embraces. A total of 73 research projects is included in the foundation's list. Those in the field of civil engineering range from work on measuring weirs (one of the earliest) and studies of paint on wood to experimental investigation of concrete arches, steel and reinforced-concrete columns, wire rope and dams—the well known Stevenson Creek test dam study. It is interesting to note also that establishment of the Highway Research Board was assisted by a grant, so that the foundation shares in the credit for the far-reaching and well coordinated study of road problems going on under the board's sponsorship.

Welding Handbook Revised

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE—6th Edition. 1117 pp. Published by The Lincoln Electric Co., Cleveland, Ohio. Price $1.50 in the United States and $2 elsewhere.

Increased in size from 1,000 to 1,100 pages, the latest edition of the Lincoln "Procedure Handbook of Arc Welding Design and Practice," is brought up to date in all departments. Changes in technique, testing, metallurgy and equipment are noted. Over 140 pages are devoted to machine design and a total of 240 to structural welding. Principal addition in the latter section is a detailed discussion of welded frame construction covering shopwork and connection detailing, calculations and design procedures.

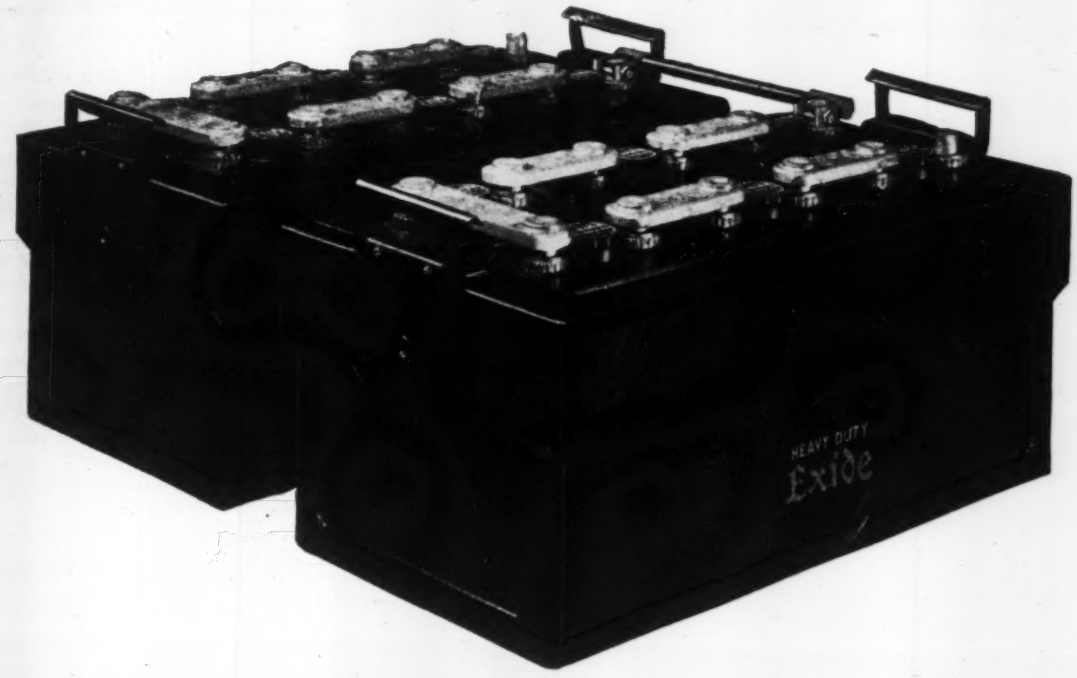
MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

TRAFFIC ACCIDENTS in St. Louis during 1939 are the subject of a report by the Department of Streets and Sewers, St. Louis, Mo. The accident statistics are analyzed and compared with 1937 and 1938. St. Louis has a low rate of 10.2 deaths per 100,000 population as compared with the average of 15.1 for cities in the 500,000 population class.

WORKMEN'S COMPENSATION LAWS are reviewed in a paper entitled "Principal Features of Workmen's Compensation Laws As of January 1, 1940," a reprint from the Monthly Labor Review as Series No. R1090, U.S. Department of Labor. Copies can be obtained from the Superintendent of Documents, Washington, D. C.

RESIDENTIAL CONSTRUCTION with plywood of all kinds is fully discussed, and some plans for small homes are given in a new 40-page

(Continued on p. 74)



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MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

(Continued from p. 74)

handbook recently published by the United States Plywood Corporation, New York, N. Y. Following a discussion of the respective merits of different plywoods is an explanation of Modular Planning, which is planning overall dimensions of houses to conform with multiples of standard plywood panel sizes. Reduction of waste is the object of this type of planning. Construction procedures and details are given, and special uses of plywood suggested.

NEW ENGINEERING BOOKS

ELEMENTS OF STRENGTH OF MATERIALS—Second Edition. By S. Timoshenko and Gleason H. MacCullough. 365 pp. Published by the D. Van Nostrand Co., Inc., 250 Fourth Ave., New York City. Price $3.25.

THE ECONOMICS OF TRANSPORTATION IN AMERICA—By Kent T. Healy. 575 pp. Published by The Ronald Press Co., 15 East 26th St., New York City. Price $4.

TRANSPORTATION — Economic Principles and Practices—By Emory R. Johnson, Grover G. Huebner and G. Lloyd Wilson. 678 pp. Published by the D. Appleton-Century Co., New York and London. Price $4.

THE NORRIS PROJECT—840 pp. Report on the planning, design, construction and initial operations of the TVA's first water control project. Technical Report No. 1. May be obtained from the Supt. of Documents, Washington, D. C. Price $1.50, cloth cover.

THE GOVERNMENT AT YOUR SERVICE—By Archie Robertson. 340 pp. Published by the Houghton Mifflin Co., 2 Park St., Boston, Mass. Price $2.75.

PROCEEDINGS OF THE MONTANA NATIONAL BITUMINOUS CONFERENCE—726 pp. Published by the Montana State Highway Department and Idaho Department of Public Works, Bureau of Highways, Helena, Montana.

HIGHWAY RESEARCH BOARD—Proceedings of the 19th Annual Meeting, 1939. 578 pp. Published by Highway Research Board, Washington, D. C.

CAPITAL EXPANSION EMPLOYMENT AND ECONOMIC STABILITY — By Harold G. Moulton, George W. Edwards, James D. Magee and Cleona Lewis. 413 pp. Published by The Brookings Institution, 722 Jackson Place, N. W., Washington, D. C. Price $3.50.

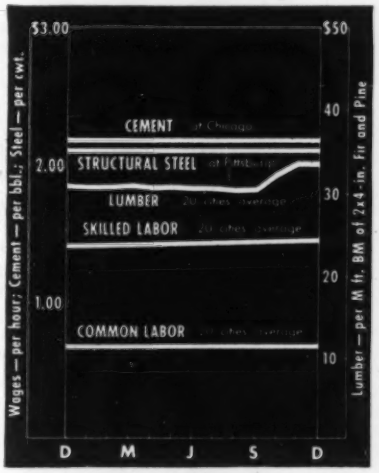
Introduction To Construction Costs—1940 Edition

STABILITY at high levels characterized the construction cost picture during 1939. In theory such steadiness is advantageous both to the buyer and builder of engineering works, but to reap the full advantage of this condition there must be a reasonable assurance that the condition will continue. This assurance did not prevail. Every job was a gamble, first with the possible success of labor to extend its wage rates beyond existing record levels, and second, with the effect of the war on price inflation. Looking backward, costs are seen to have been stable, but the view from the firing line was usually clouded in mists of uncertainty.

Such conditions in no wise depreciate the value of complete, up-to-date cost data, however; what knowledge we have of costs and cost trends is, indeed, the principal anchor available in the economic storms that accompany war. As a consequence this 1940 edition of Construction Costs should be even more valuable than those of previous years. As always the guiding objective in its preparation is to present figures in useful and useable form. No attempt is made at interpretation, the collected data constituting a reference manual rather than a series of discussions of costs.

As an introduction to the material presented in the following 75 pages, a brief summary of 1939 may be useful. In volume of work, it exceeded every year since 1930. Public works, accounting for 53.5 per cent of the total, was at the highest level ever attained; in private engineering and residential work, only 1930 was larger during the past decade. Over 1938, an 8 per cent construction gain was registered and over 1932, the low point, the gain was 145 per cent. Activity here is measured in dollars. In view of the high cost levels obtaining, physical volume of construction may be a better measure and, according to the *ENR* Volume Index which is adjusted for cost changes, the physical gains over 1938 and 1932 were 7 and 65 per cent, respectively.

Now as to costs. Excepting only a brief period in 1920, the all-time high of the *ENR* Construction Cost Index



Labor and material prices in 1939 that affected *ENR* Cost Indexes.

(241.90) occurred in October, 1937. As against this, the December, 1938 figure was 234.89 and the December, 1939 figure, 238.17, so we gradually moved back toward the peak. Costs for the year as a whole, however, averaged 0.2 per cent lower than in 1938. The 1939 trend line shows a slight decline during the first three months of the year followed by six months of stability and then a rise in the last quarter occasioned by increased lumber prices.

The *ENR* Building Cost Index, in which a skilled labor component is substituted for the common labor component in the Construction Cost Index, averaged 0.3 per cent higher than in 1938, and the level at the end of the year topped the January, 1939 figure by 2.3 per cent. This building cost rise compared to only 1.5 per cent in general construction costs, which is explained by a larger wage rate increase for skilled labor than for common.

New cost factors are entering into construction. The American Appraisal Co.'s index was revised this year to take account of such new factors as unemployment insurance, public liability insurance, old age pensions, etc., with a significant result: before revision the index stood at 183 for 1939 while after revision it was 200, a rise of 9 per cent.

Against this rise in construction, another study in this issue (see p 126) shows how efficiency in management and mechanization is forcing actual costs below those indicated by indexes.

Construction wage averages in the common labor field stayed within a range of ½ cent in 1939; the 20-cities average for the year of 68.3 cents an hour was an all-time high.

The skilled construction average rate for 20-cities revealed a wider gain than in the common labor field, and at $1.443 was the highest ever reported. Bricklayers' and carpenters' rates were up 1.9 per cent and structural iron workers up 2.6 per cent.

Construction material price averages were generally higher, with lumber gaining 8, common brick 2.7, and cement 3.8 per cent at New York. Structural steel shapes at Pittsburgh, however, dropped 3.7 per cent below the 1938 average. Long leaf yellow pine was $63 for the first ten months and then jumped to $68.50. Common brick opened the year at $13.50 and closed at $13, but by February, 1940 the price had been increased to $14.50.

A brief survey of our present position in June, 1940 reveals some important changes from the 1939 picture. Private construction is up 14 per cent, public construction down 26 per cent, for a net loss of 16 per cent. The *ENR* Construction Cost Index took its first real jump this month when it rose 1.1 per cent as a result of a one cent increase in the common labor rate to 70 cents an hour; at its present level it is only 0.31 points below the October, 1937 peak. All skilled rates are also up but the rise in all cases has been less than 1 per cent. Cement prices are down 2.7 per cent, structural steel unchanged, lumber up 0.2 to 0.5 per cent and brick down 0.1 per cent. It is clear that the period of uncertainty about rising costs still persists.

ENR Construction Cost Index

THE *Engineering News-Record* Construction Cost Index has four components, (1) structural steel shapes at Pittsburgh; (2) cement at Chicago; (3) lumber, which until 1935 was 12 x 12 long leaf yellow pine wholesale at New York, and since 1935 is 2 x 4 S4S pine and fir in carload lots, *ENR* 20-cities average; (4) common labor, *ENR* 20-cities average of wage rates in force.

The weighting for the original price series is given in the following computation for the December, 1934 index:

Steel	25 cwt. x 1.80 = 45.00
Lumber	0.6 x 61.00 = 36.60
Cement	6 x 2.00 = 12.00
Labor	200 x .5413 = 108.26
Index	201.86

The weighting for the new lumber price series is 1.088, and the computation for January, 1940 index is:

Steel	25 cwt. x 2.06[illegible] = 51.69
Lumber	1.088 x 33.[illegible] = 36.51
Cement	6 x 2.19 = 13.14
Labor	200 x .6[illegible] = 137.00
Index	238.34

This Construction Cost Index is designed to predict changes in construction cost trends and to measure the movement of construction costs in general. It is not intended to apply to any specific class of construction or to a particular locality.

ENR Building Cost Index

In practice, the construction cost index has been used widely to apply

Engineering News-Record BUILDING Cost Index—1913 = 100

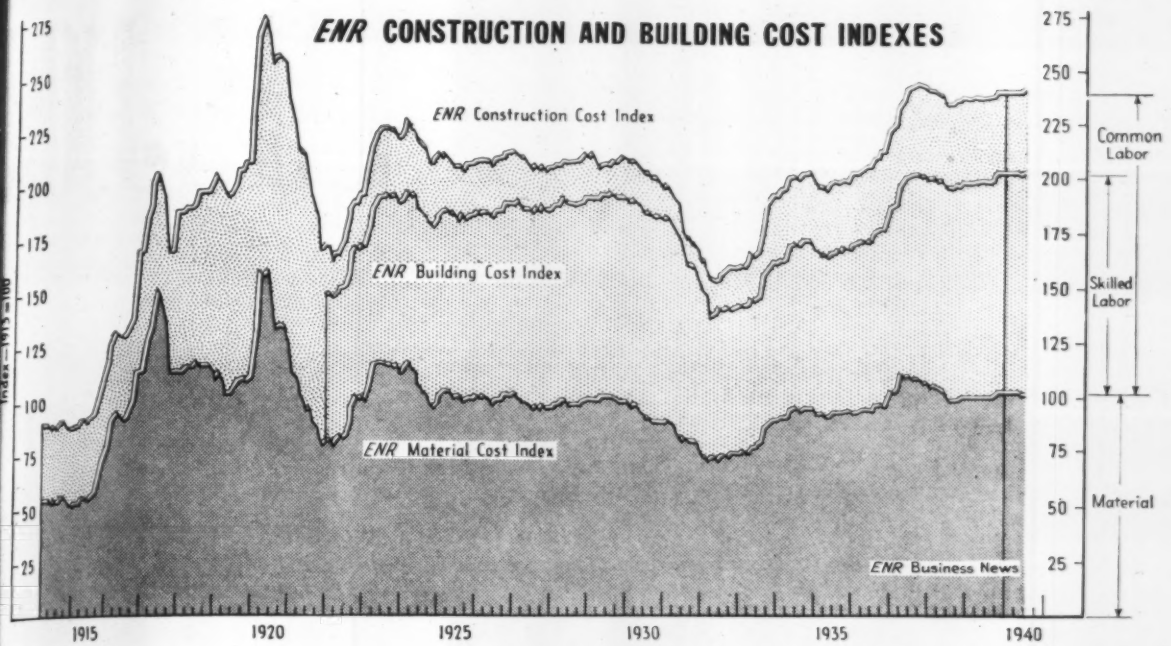
Yearly Aver. prior to 1922			1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935†	1936†	1937†	1938†	1939†	1940†
1910	96.4	J	147.1	168.2	189.3	182.7	184.3	187.8	185.9	190.0	190.3	180.7	150.6	140.8	160.2	166.5	168.3	185.5	198.6	196.2	201.5
1911	94.1	F	146.5	172.6	191.7	184.5	183.7	189.2	187.2	190.0	188.5	182.0	147.2	141.7	161.3	165.8	168.4	186.6	199.0	196.2	201.5
1912	91.4	M	145.2	178.4	194.1	184.5	184.3	187.3	187.2	190.0	189.2	180.2	145.9	140.8	161.7	164.1	169.7	187.7	199.3	196.5	201.5
1913	100.0	A	147.1	186.0	191.8	184.7	184.1	186.0	188.8	190.0	188.8	177.6	135.7	141.5	163.2	164.4	170.0	195.0	198.2	196.5	201.4
1914	91.9	M	149.0	188.9	192.5	182.8	183.6	185.4	190.1	191.3	187.9	174.6	136.4	143.9	168.2	163.3	170.3	197.2	197.9	196.6	201.2
1915	95.3	J	149.8	191.3	187.7	183.0	181.8	185.8	187.6	192.0	185.4	172.5	137.6	143.2	168.2	164.9	170.2	199.2	198.2	196.4	201.7
1916	130.9	J	150.9	191.4	184.5	180.2	184.3	183.9	187.6	192.0	183.3	170.5	139.5	144.3	169.2	165.3	170.9	199.8	194.4	196.8	
1917	166.8	A	154.6	191.5	183.3	183.0	185.1	186.5	187.6	192.8	183.7	163.1	139.4	145.9	168.4	166.2	173.9	200.7	194.5	196.5	
1918	159.1	S	164.2	192.2	181.4	180.5	185.1	184.6	187.6	191.6	182.4	159.5	139.6	154.5	170.1	166.1	174.3	200.6	194.8	196.6	
1919	158.8	O	167.8	191.0	178.4	181.8	188.0	186.6	187.6	190.3	181.8	159.5	140.0	157.1	170.2	167.3	175.3	201.0	195.5	198.5	
1920	207.2	N	167.1	192.4	176.5	182.4	188.0	185.0	188.0	190.3	181.8	158.3	139.5	159.0	170.2	167.3	175.5	200.3	195.6	201.2	
1921	166.1	D	169.1	188.0	178.4	183.1	188.0	185.1	190.0	190.3	181.8	155.0	140.0	160.7	170.2	167.2	179.3	200.5	196.1	201.2	
		Aver.	154.9	186.0	185.8	182.7	185.0	186.1	188.0	190.9	185.4	169.4	140.9	147.8	166.7	165.8	172.2	196.2	196.8	197.4	

Engineering News-Record CONSTRUCTION Cost Index—1913 = 100

Yearly averages prior to 1914			1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
		J	89.22	87.12	112.66	167.75	184.51	198.05	206.55	2370.8	168.72	191.70	217.90	210.40	207.15	211.50	203.90	209.40	208.96
1903.....	93.90	F	89.22	87.36	116.66	167.75	184.51	201.50	225.10	230.67	168.72	197.40	220.30	209.70	206.55	210.15	204.65	210.40	206.46
1904.....	87.40	M	88.97	87.66	125.16	175.66	184.51	198.05	240.85	224.27	162.04	205.25	224.70	210.20	207.65	208.80	204.65	207.78	206.80
1905.....	90.55	A	87.97	90.16	129.51	183.41	186.01	191.25	265.20	213.07	164.72	213.50	221.60	209.55	207.05	209.00	206.40	203.40	207.12
1906.....	95.10	M	88.62	90.16	131.06	187.61	186.01	191.25	268.90	210.82	164.62	216.70	222.38	207.20	207.30	206.80	207.00	205.15	205.86
1907.....	100.55	J	87.87	88.96	128.71	199.26	186.31	191.85	273.80	209.82	166.62	220.70	216.85	204.60	204.80	205.55	206.15	205.65	203.36
1908.....	97.20	J	88.12	90.51	127.96	204.01	188.65	193.65	265.65	203.82	169.70	222.10	214.40	204.60	207.80	203.68	206.65	204.77	200.95
1909.....	90.92	A	90.11	91.76	128.76	198.41	193.85	196.65	252.00	193.47	173.40	221.50	213.15	204.60	208.30	205.50	207.29	205.91	200.95
1910.....	96.33	S	90.36	93.01	131.76	190.31	193.85	202.85	255.20	188.27	185.00	221.50	211.25	202.10	208.30	203.60	207.29	207.57	199.58
1911.....	93.43	O	88.51	96.16	135.11	167.11	193.85	202.25	255.20	182.57	188.60	220.30	207.55	205.35	209.80	204.40	207.71	206.32	198.72
1912.....	90.70	N	87.26	101.06	138.16	166.51	193.55	206.85	255.32	166.32	188.60	220.90	205.70	205.95	210.80	201.98	209.46	208.46	198.54
1913.....	100.00	D	86.51	107.06	149.41	167.11	194.75	206.85	251.62	167.82	192.60	217.30	208.58	205.95	210.80	203.90	210.16	209.46	196.86
		Aver.	88.56	92.58	129.58	181.24	189.20	198.42	251.28	201.81	174.45	214.07	215.36	206.68	208.03	206.24	206.78	207.02	202.85

Engineering News-Record CONSTRUCTION Cost Index—1926 = 100

Yearly averages prior to 1914			1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
	1926 = 100																		
		J	42.9	41.9	54.2	80.6	88.7	95.2	99.3	110.0	81.1	92.2	104.7	101.1	99.6	101.7	98.0	100.6	100.4
		F	42.9	42.0	56.1	80.6	88.7	96.9	108.2	110.9	81.1	94.9	105.9	100.8	99.3	101.0	98.4	101.1	99.2
1903.....	45	M	42.8	42.1	60.3	84.4	88.7	95.2	115.8	107.8	77.9	98.7	108.0	101.0	99.8	100.3	98.4	99.9	99.5
1904.....	42	A	42.2	43.3	62.0	88.2	89.5	91.9	127.5	102.4	79.2	102.6	106.5	100.7	99.5	100.4	99.2	97.8	99.6
1905.....	43½	M	42.6	43.3	63.0	90.2	89.5	91.9	129.3	101.3	79.1	104.2	106.9	99.6	99.7	99.4	99.6	98.6	99.0
1906.....	46	J	42.2	42.7	61.9	95.8	89.5	92.2	131.6	100.9	80.1	106.1	104.3	98.4	98.5	98.8	99.1	98.9	97.8
1907.....	51	J	42.4	43.5	61.5	98.1	90.7	93.1	127.6	98.0	81.6	106.8	103.1	98.4	99.9	97.9	99.3	98.4	96.6
1908.....	47	A	43.3	44.1	62.0	95.4	93.2	94.5	121.1	93.0	83.4	106.5	102.4	98.4	100.1	98.8	99.6	99.0	96.6
1909.....	44	S	43.4	45.1	63.3	91.5	93.2	97.5	122.7	90.5	88.9	106.5	101.5	97.1	100.1	97.9	99.6	99.8	95.9
1910.....	46	O	42.5	46.2	64.8	80.3	93.2	97.2	122.7	87.8	90.7	105.9	99.8	98.7	100.9	98.3	99.8	99.2	95.5
1911.....	45	N	41.9	48.4	66.4	80.0	93.0	99.4	122.7	80.0	90.7	106.2	98.9	99.0	101.3	97.1	100.7	100.2	95.4
1912.....	43½	D	41.1	51.4	71.8	80.3	93.6	99.4	121.0	80.6	92.6	104.5	100.2	99.0	101.3	98.0	101.0	100.7	94.6
1913.....	48																		
		Aver.	42.5	44.5	62.2	87.1	90.9	95.3	120.8	97.0	83.8	102.9	103.5	99.4	100.0	99.1	99.4	99.5	97.5



building costs, and when common and skilled labor rates move in similar trends it is a satisfactory measure of relative building cost movement. However, following the low wage rates of 1932, common labor climbed much faster than skilled and reached new all-time highs by July, 1937. The increase was in the lower ranges between union and non-union. When "prevailing" wages became synonymous with union wages the gap closed up, hence the *ENR* 20-cities wage average increased more rapidly than the union rates.

To provide a more representative measure of building cost movement, the skilled labor trend has been substituted for the common labor trend in the *ENR* Construction Cost index, and the *ENR* Building Cost index computed. The labor weighting applied to the *ENR* skilled labor average for 20-cities thus becomes 68.38 hr., and the computation for the Jan. 1940 Building Cost Index is:

Steel	25 cwt. x 2.0675 =	51.69
Lumber	1.088 x 33.56 =	36.51
Cement	6 x 2.19 =	13.14
Labor	68.38 x 1.465 =	100.18
Index		201.52

* Superseded by figures in last four columns using 2 x 4 fir and pine lumber component.
† Based on 2 x 4 S4S fir and pine *ENR* 20 cities average lumber component instead of 12 x 12 yellow pine wholesale in New York used prior to 1935. For explanation see page C-5 of June 30, 1938 *ENR*.

CONSTRUCTION Cost Index—1913 = 100

1931	1932	1933	1934	1935*	1936*	1937*	1935†	1936†	1937†	1938†	1939†	1940†	
194.48	162.48	158.44	191.26	198.72	199.48	223.45	198.22	201.23	221.20	239.62	234.72	238.34	J
196.61	161.82	159.30	194.06	196.02	201.20	223.45	195.07	201.33	222.05	238.99	234.31	238.32	F
194.51	157.24	158.44	194.06	194.26	201.20	225.25	194.41	201.63	224.75	238.79	234.43	238.29	M
191.63	153.12	160.16	195.86	194.50	202.20	230.25	194.65	202.80	231.35	237.95	234.86	238.26	A
189.33	152.78	164.39	199.61	194.06	203.40	233.25	193.96	204.05	233.45	236.80	234.69	238.86	M
187.23	152.20	163.41	199.61	194.78	204.60	238.15	196.73	205.08	237.25	236.86	235.02	241.59	J
174.37	153.36	165.50	199.65	195.18	204.40	241.75	197.43	204.80	239.90	232.29	234.94	.....	J
171.38	156.80	167.00	198.40	195.10	208.10	242.95	197.45	208.48	240.65	232.39	234.90	.....	A
171.40	157.96	175.48	200.58	195.10	208.10	243.95	197.30	208.88	241.62	232.70	234.97	.....	S
169.78	159.16	187.74	200.86	195.10	211.50	244.55	197.50	211.53	241.90	234.30	236.86	.....	O
169.28	158.20	190.14	201.36	194.90	212.70	244.95	197.35	211.50	241.40	234.40	238.20	.....	N
166.23	158.46	192.14	201.86	194.90	220.05	244.95	197.20	215.70	241.05	234.89	238.17	.....	D
181.35	156.97	170.18	198.10	195.22	206.41	236.41	196.44	206.42	234.71	235.86	235.51	.....	Aver

CONSTRUCTION Cost Index—1926 = 100

1931	1932	1933	1934	1935*	1936*	1937*	1935†	1936†	1937†	1938†	1939†	1940†	
93.5	78.1	76.2	91.9	95.5	95.9	107.41	95.3	96.7	106.2	114.9	112.9	114.6	J
94.5	77.8	76.6	93.3	94.2	96.7	107.41	93.8	96.8	106.7	114.9	112.7	114.6	F
93.5	75.6	76.2	93.3	93.4	96.7	108.18	93.5	96.9	108.0	114.8	112.7	114.6	M
92.1	73.6	77.0	94.1	93.5	97.2	110.64	93.5	97.5	111.2	114.4	112.9	114.5	A
91.0	73.4	79.0	95.9	93.3	97.8	112.08	93.2	98.2	112.0	113.8	112.8	114.8	M
90.0	73.2	78.5	95.9	93.6	98.4	114.48	94.6	98.5	113.8	113.9	113.0	116.1	J
83.8	73.7	79.6	96.0	93.8	98.3	116.21	94.9	98.4	115.1	111.7	112.9	.....	J
82.4	75.4	80.3	95.4	93.8	100.0	116.78	94.9	100.2	115.7	111.7	112.9	.....	A
82.4	75.9	84.4	96.4	93.8	100.0	117.27	94.9	100.4	115.9	111.9	113.0	.....	S
81.6	76.5	90.2	96.6	93.8	101.7	117.55	95.0	101.5	116.1	112.7	113.9	.....	O
81.4	76.0	91.4	96.8	93.7	102.2	117.75	94.9	101.5	115.8	112.7	114.5	.....	N
79.9	76.2	92.4	97.0	93.7	105.8	117.75	94.8	103.4	115.7	112.9	114.5	.....	D
87.1	75.4	81.8	95.2	93.8	99.2	113.63	94.4	99.2	112.7	113.3	113.2	.....	Aver.

Base Conversion Table

To convert *ENR* Construction and Building Cost Indexes

From 1913 = 100 Base To	Divide 1913 = 100 Values By	
	Const. Cost	Bldg. Index
1926 = 100	2.0803	1.8499
1929 = 100	2.0702	1.9086
1910–14 = 100	.9380	.9477
1924 = 100	2.1536	1.8578
1923–25 = 100	2.1204	1.8481
1914 = 100	.8856	.9191
1911 = 100	.9343	.9414

That DAM Job

THERE are 2,700,000 cubic yards of excavation, a 5,700 foot earth embankment to build at the Great Salt Plains Dam Project at Jet, Oklahoma.

Mittry Bros. Construction Company, Los Angeles contractor, is using Texaco Fuels and Lubricants 100% on this job.

Texaco Fire-Chief Gasoline and *Insulated Havoline Motor Oil* keep engines free from gum, with rings active to assure piston seal and full power.

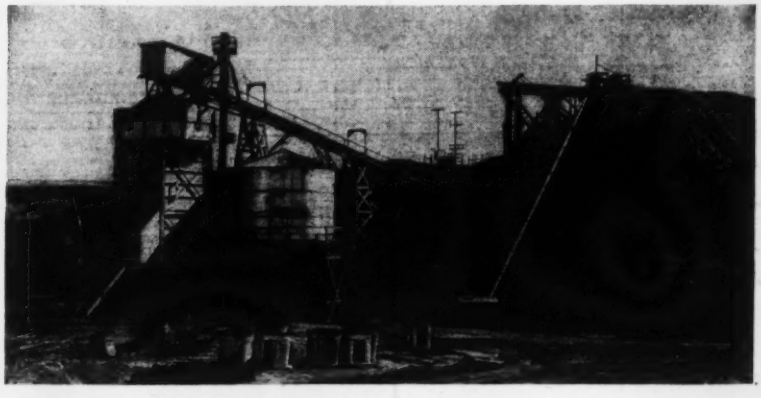
Texaco Marfak protects chassis and wheel bearings of all trucks, tractors, bulldozers, shovels.

Texaco Thuban provides outstanding service in transmissions, differentials and other final drives.

The crankcases of all "Cats" are filled with *Texaco Ursa X*.

You, too, can use Texaco Industrial Lubricants to advantage. A lubrication engineer will gladly demonstrate their savings. Phone the nearest of more than 2300 Texaco warehousing points, or write:

The Texas Company, 135 East 42nd Street, New York, N. Y.



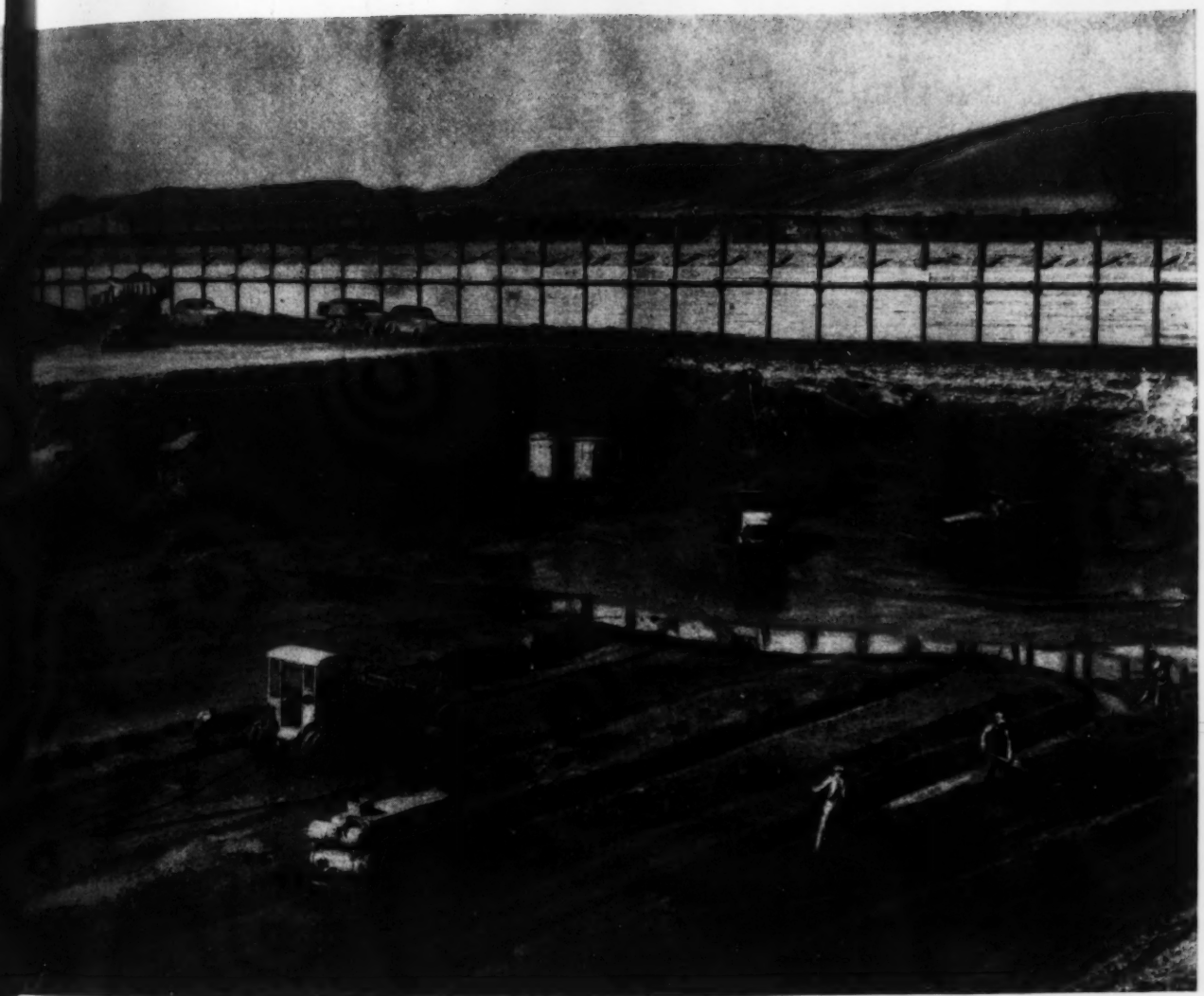
SCREENING PLANT at Jet, Okla. Part of job is a man-made lake of 10,000 acres, 9 miles wide. 800 working days' time limit. Fuel and lubricants in use...Texaco.

Texaco Dealers invite you to tune in The Texaco Star Theatre — a full hour of all-star entertainment — Every Wednesday Night — Columbia Network — 9:00 E.D.T., 8:00 E.S.T., 8:00 C.D.T., 7:00 C.S.T., 6:00 M.S.T., 5:00 P.S.T.

TEXACO

TEXACO

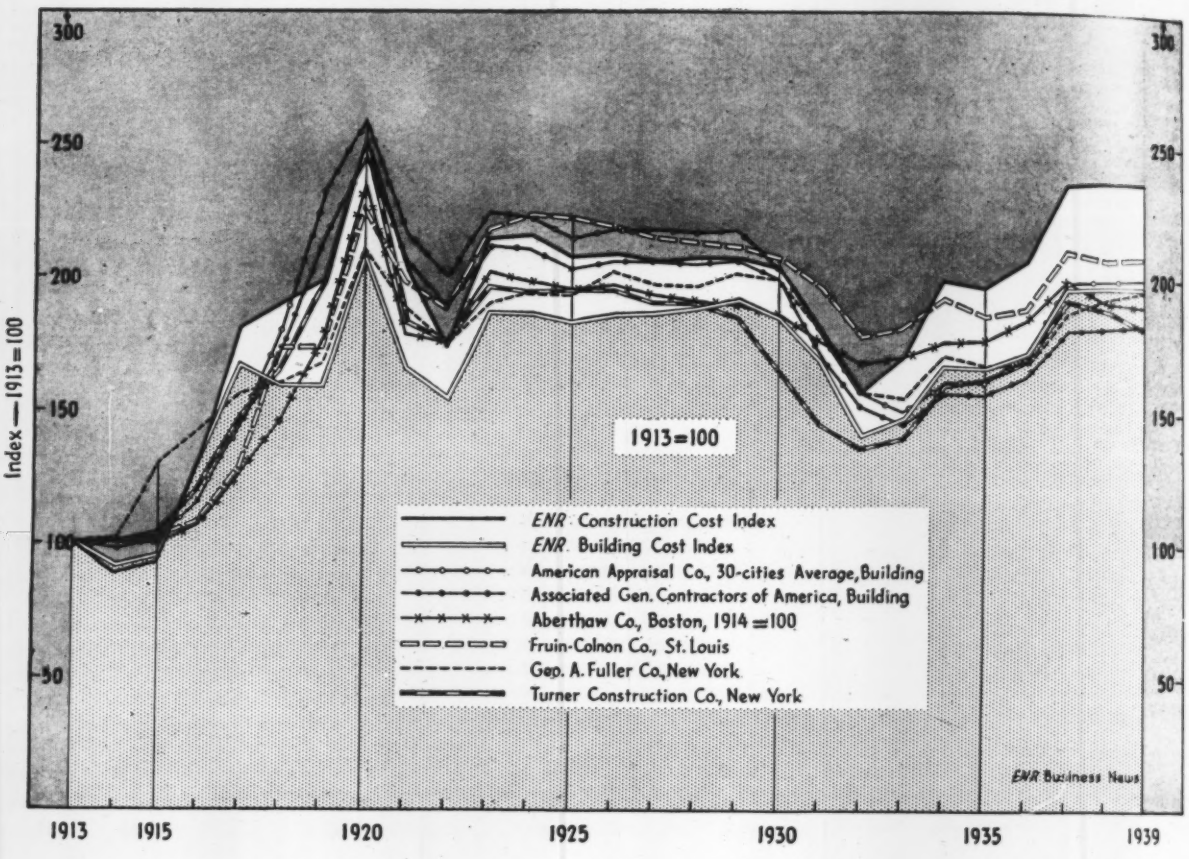
at Jet . . .



GENERAL VIEW of Great Salt Plains Dam Project . . . for water conservation, flood control, wild-life sanctuary. Texaco lubricated 100%.

Truck Lubricants

Special Building Cost Indexes



New American Appraisal Company Construction Cost Trend Index — 1913 = 100

For average of four types of buildings: All Frame, Brick Wood Frame, Brick Steel Frame and Reinforced Concrete.

These indices cover structural items only, and do not include factors for Plumbing, Heating, Lighting, Elevators, etc.

	1914	'15	'16	'17	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39
U. S. AVERAGE 1913 to 1924—24 Cities 1925 to 1939—30 Cities	98	101	116	143	177	229	283	216	200	224	222	217	217	217	217	217	200	178	155	150	161	162	170	198	199	200
BOSTON	100	103	118	149	183	234	288	220	209	232	229	224	224	222	222	224	212	195	169	163	170	169	178	212	209	210
NEW YORK	99	100	115	142	175	227	299	245	219	245	241	230	234	234	235	237	219	201	170	167	176	174	182	213	216	218
BUFFALO	98	99	115	144	180	232	278	214	197	228	225	218	219	217	213	212	195	178	157	150	160	158	165	202	206	205
BALTIMORE	97	99	116	150	193	239	289	215	206	233	229	226	224	226	227	228	211	186	166	158	167	173	180	200	200	198
PHILADELPHIA	98	102	115	145	181	236	300	220	201	232	230	224	225	228	227	227	209	190	161	156	166	166	171	193	194	196
PITTSBURGH	97	99	115	142	179	231	290	221	201	228	238	233	236	237	236	236	217	198	172	161	170	168	177	211	219	219
CINCINNATI	99	100	115	143	173	217	276	211	194	221	221	219	217	219	219	220	202	176	157	151	161	162	174	206	209	208
CLEVELAND	97	99	120	149	179	233	303	227	210	241	243	236	233	231	232	232	213	188	160	151	164	168	175	208	207	206
CHICAGO	97	100	116	141	170	224	294	226	202	228	225	224	219	222	222	222	205	185	162	156	166	169	179	204	205	205
INDIANAPOLIS	102	104	119	146	175	221	279	221	202	225	227	222	219	222	224	224	206	182	157	150	161	161	169	199	204	205
DETROIT	99	102	122	150	187	244	304	220	200	229	227	226	224	222	221	220	202	174	148	146	157	160	168	203	205	207
MILWAUKEE	100	103	120	150	178	237	290	212	195	224	224	217	218	219	220	218	197	163	144	141	156	163	178	208	208	209
MINNEAPOLIS	98	100	114	142	171	218	277	210	193	214	208	201	197	197	197	198	182	165	148	146	154	154	162	199	201	202
KANSAS CITY	98	102	120	150	184	239	280	220	211	231	228	220	220	215	213	213	193	178	156	149	160	162	169	202	209	209
ST. LOUIS	97	100	114	141	175	228	284	225	204	228	238	233	230	226	225	224	205	188	163	156	166	164	171	207	207	207
ATLANTA	97	98	111	140	186	250	304	218	202	226	217	209	211	214	215	215	195	173	147	142	162	163	170	192	185	187
DALLAS	100	105	121	145	176	227	274	209	191	209	206	198	204	204	202	202	187	168	146	139	149	148	154	170	168	171
NEW ORLEANS	97	96	113	136	174	239	282	217	201	225	227	216	217	218	215	215	198	170	145	141	159	159	166	186	187	194
DENVER	100	102	118	145	171	216	262	206	191	202	206	204	204	202	205	207	189	168	149	141	150	151	157	190	193	195
SEATTLE	96	101	115	141	176	224	268	197	186	207	206	201	199	195	194	198	184	159	141	136	150	154	161	194	193	195
SAN FRANCISCO	97	104	118	139	169	214	258	204	189	208	199	194	188	188	188	190	177	158	144	138	145	144	155	178	176	180
LOS ANGELES	97	102	112	133	162	213	251	208	199	213	204	197	195	193	193	196	178	157	141	134	142	140	143	165	166	167

NOTE — These construction cost index figures are based on 1913 as 100% for each individual location, thus indicating the trend in each city and not the trend between the various locations. The index figures are calculated on the basis of normal average material prices, average labor wages, and the market conditions in the individual cities and do not reflect extremes such as premium prices and overtime wages for rush work during boom periods or the "extreme low" of cut throat practices during the "depression periods."

Construction and Building Cost Indexes—1913 through 1939

Year	AAC (Old)	AAC (New)	AGC	*ENR* Bldg.	*ENR* Const.	Boeckh New York	Handy R. C. Atl. Seab'd.	ICC–RR Sta. & Off. Bldg.	Aber-thaw	Austin Co.	Fruin-Colnon	Fuller	Tilgh-man Moyer	Turner
Base = 100	1913	1913	1913	1913	1913	1913	1911–'14	1910–'14	1914	1913	1913	1913	1913	1913
1913.....	100	100	100	100	100	100	...	...	...	100	100	100	100	100
1914.....	98	98	99	92	89	102	...	...	100	105	100	102	92	100
1915.....	101	101	100	95	93	99	...	101	100	115	102	130	96	103
1916.....	116	116	114	131	130	116	153	115	107	141	108	143	115	120
1917.....	144	143	152	167	181	135	233	135	126	172	128	156	142	147
1918.....	172	177	175	159	189	155	242	154	147	206	173	160	148	166
1919.....	213	229	198	159	198	171	237	185	172	198	174	168	190	196
1920.....	270	283	247	207	251	230	260	215	234	241	227	209	258	252
1921.....	205	216	200	166	202	193	207	192	179	180	197	188	210	183
1922.....	189	200	184	155	174	187	165	180	170	157	188	175	177	175
1923.....	212	224	201	186	214	215	199	194	202	181	217	190	214	196
1924.....	210	222	202	186	215	215	226	193	198	181	223	194	212	194
1925.....	203	217	199	183	207	211	219	188	195	185	222	193	209	195
1926.....	206	217	197	185	208	230	213	184	197	185	218	202	207	195
1927.....	206	217	200	186	206	223	208	189	193	178	214	197	202	190
1928.....	205	217	199	188	207	238	205	188	191	172	213	196	204	190
1929.....	206	217	203	191	207	242	211	187	190	170	211	201	208	185
1930.....	199	200	200	185	203	238	200	182	186	155	207	199	196	165
1931.....	171	178	196	169	181	230	184	165	176	131	196	180	170	145
1932.....	152	155	171	141	157	208	165	141	168	117	178	157	150	136
1933.....	146	150	163	148	170	197	159	145	170	117	181	155	152	140
1934.....	157	161	178	167	198	209	186	151	176	128	191	171	163	160
1935.....	157	162	176	166	196	200	190	151	177	139	185	167	178	162
1936.....	163	170	179	172	206	205	192	157	184	150	188	168	188	169
1937.....	181	198	188	196	235	226	208	166	199	165	210	187	214	192
1938.....	182	199	189	197	236	243	210	166	191	161	207	192	221	188
1939.....	183	200	188	197	236	248	206	...	190	152	208	195	229	182

Descriptions of Leading Building and Construction Cost Indexes

American Appraisal Company (AAC)—Average for 30 cities of four types of buildings: wood frame, brick-wood frame, brick-steel frame, reinforced concrete. Mechanicals not included. Based on actual appraisal costs. Available for individual cities (see preceding page). Recently revised to include adjustments for social security taxes, unemployment insurance and corresponding "overhead". Base: 1913=100.

Associated General Contractors of America (AGC)—Wages and materials for 12 cities combined in 40-60 ratio. Wages, prevailing rates for hod carriers and common labor. Materials, weighted: sand, gravel and crushed stone, 1; cement, 1; lumber, 1; hollow tile, ½; structural and reinforcing steel, ½. Base: 1913=100.

Engineering News-Record Building Cost (ENR Bldg.)—For complete description see pages 88 and 89.

Engineering News-Record Construction Cost (ENR Const.)—For complete description see pages 88 and 89.

E. H. Boeckh & Assoc., Inc.—Individual series for ten types of buildings for sixteen areas. (See page 102.) Weights based on studies of actual building costs—vary with different type of structures. Labor efficiency correction used. Material prices from local building trade papers. Prevailing skilled and common wage rates from contractors. Base: United States average, 1926-29=100. Series given here is brick and concrete, New York, converted to 1913=100 base.

Handy Public Utility Construction Cost—Compiled and published Jan. 1 and July 1 of each year by Whitman, Requardt & Smith. (See page 98.) Individual series for 81 cost elements in three classes of utility construction, for five geographic divisions of United States.

Weighting based on wide experience in cost analysis of plant and construction. Material prices from Engineering News-Record and Iron Age. Labor cost trends from U. S. Dept. of Labor and National Association of Builders Exchanges. Base 1911-14=100. The reinforced concrete building construction series is tabulated in this table.

Railroad Construction Index (ICC-RR)—Compiled by Engineering Section, Bureau of Valuation, Interstate Commerce Commission. (See page 96.) Indexes for road (47 subseries), equipment (8 subseries), and general expenditures (7 subseries) for national average and 8 regional areas. Series quoted here is road, subseries 16, station and office buildings, national average. Computed from analysis of contracts covering major construction projects over 30-year period, and other information furnished by carriers. Base: 1910-14=100.

Aberthaw—New England, seven-story and basement (62'4"x202'4"), reinforced concrete building built in 1914, repriced quarterly as a construction bid to duplicate original building. Labor costs based on current experience with similar construction. Base: 1914=100.

Austin Industrial Building Cost—Repricing typical one-story, steel frame, monitor type industrial building at regular intervals. Structure has concrete foundations, curtain walls of brick and large areas of steel sash and glass; concrete floor laid on ground; 2-in. lumber roof deck on heavy timber covered with 4-ply waterproofing. Monitor sash equipped with mechanical operators. Pricing at representative points in central and eastern states. Base: 1926=100. Series in table converted to 1913=100 base.

Fruin-Colnon—Industrial plant of five buildings in St. Louis repriced on basis of contractor's actual and estimated material and labor costs. Base: 1913=100.

George A. Fuller Company—Composite of 36 major cost elements, in three commercial type buildings, including mechanicals, elevators, wiring, heating and ventilating, repriced. Base 1913 = 100.

Tilghman Moyer Company—Compiled monthly from actual cost records in construction of bank buildings. Includes all typical building items, and, in addition, all fixtures which are special in bank work, which in many cases exceed structural costs. Index reflects saving occasioned by use of reconditioned equipment from closed banks. Base: 1913=100.

Turner Construction Company—Eastern cities. Own building cost experience applied to these factors: labor rates, material prices, productivity of labor, efficiency of plant and management, competitive conditions. Base: 1913=100.

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Birmingham, Ala.
Boston, Mass.
Buffalo, N. Y.
Butte, Mont.
Canton, Ohio
Cedar Rapids, Iowa
Charleston, S. C.
Charleston, W. Va.
Charlotte, N. C.
Chattanooga, Tenn.
Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Columbus, Ohio
Dallas, Texas
Davenport, Iowa
Dayton, Ohio
Denver, Colo.
Des Moines, Iowa
Detroit, Mich.
Duluth, Minn.
El Paso, Texas
Erie, Pa.
Evansville, Ind.
Flint, Mich.
Fort Wayne, Ind.
Fort Worth, Texas
Grand Rapids, Mich.
Greenville, S. C.
Hartford, Conn.
Houston, Texas
Indianapolis, Ind.
Jackson, Mich.
Jackson, Miss.
Jacksonville, Fla.
Kansas City, Mo.
Knoxville, Tenn.
Lansing, Mich.
Lincoln, Nebr.
Los Angeles, Calif.
Louisville, Ky.
Madison, Wis.
Memphis, Tenn.
Miami, Fla.
Milwaukee, Wis.
Minneapolis, Minn.
Nashville, Tenn.
Newark, N. J.
New Haven, Conn.
New Orleans, La.
New York, N. Y.
Niagara Falls, N. Y.
Oklahoma City, Okla.
Omaha, Nebr.
Peoria, Ill.
Philadelphia, Pa.
Phoenix, Ariz.
Pittsburg, Kan.
Pittsburgh, Pa.
Portland, Me.
Portland, Ore.
Providence, R. I.
Raleigh, N. C.
Reading, Pa.
Richmond, Va.
Roanoke, Va.
Rochester, N. Y.
Rockford, Ill.
St. Louis, Mo.
Salina, Kan.
Salt Lake City, Utah
San Antonio, Texas
San Diego, Calif.
San Francisco, Calif.
Schenectady, N. Y.
Seattle, Wash.
Shreveport, La.
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South Bend, Ind.
Spokane, Wash.
Springfield, Ill.
Springfield, Mass.
Syracuse, N. Y.
Tacoma, Wash.
Tampa, Fla.
Toledo, Ohio
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Waterloo, Iowa
Wichita, Kan.
Worcester, Mass.
Youngstown, Ohio

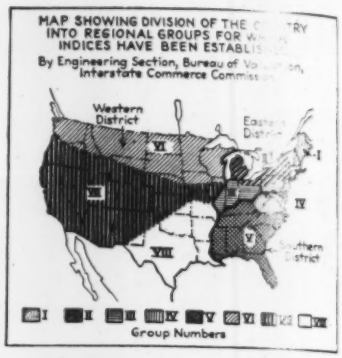
YOU GET GREATER SPEED AND SAFETY—CLEAR A BIGGER NET—WHEN YOU OPERATE ELECTRICALLY

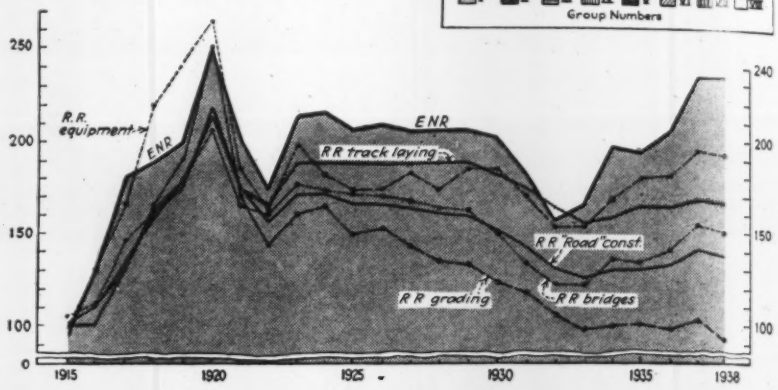
GENERAL ELECTRIC

011-488

Railroad Construction Cost Indexes

THESE indexes by Engineering Section, Bureau of Valuation, Interstate Commerce Commission, include items such as grading, tunnel excavation, bridges, ballast haul, track-laying and surfacing, developed from analysis of major construction contracts over a period of 30 years. Indexes for material accounts such as ties, rails, other track material, ballast and fences are based on studies of carriers' returns to Valuation Order 14, joint studies made with various sub-committees of Presidents' Conference Committee, well-known engineering and trade publications, contracts covering major construction projects over a period of 30 years, and other information furnished by individual carriers.


MAP SHOWING DIVISION OF THE COUNTRY INTO REGIONAL GROUPS FOR WHICH INDICES HAVE BEEN ESTABLISHED
By Engineering Section, Bureau of Valuation, Interstate Commerce Commission
Western District
Eastern District
Southern District
Group Numbers



Railroad Cost Indexes for Regions by Years for "Road" Construction — 1910-14 = 100

Total of Accounts 1-46, ROAD, Engineering Section, Bureau of Valuation, Interstate Commerce Commission, July 1, 1939

United States	Per Cent	Index by Years 1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
Reg. I to VIII...	**73.09**	**134**	**159**	**178**	**214**	**175**	**157**	**171**	**171**	**166**	**166**	**164**	**161**	**160**	**152**	**143**	**131**	**127**	**131**	**131**	**133**	**142**	**138**
Reg. I.....	75.36	138	162	184	220	178	163	177	178	172	173	171	167	166	158	146	134	131	133	134	136	146	141
Reg. II.....	68.15	134	160	180	214	176	160	174	174	168	168	167	165	164	157	145	133	130	134	134	136	146	142
Reg. III.....	67.99	135	160	180	214	176	160	173	173	169	168	167	164	163	155	143	132	129	133	133	136	146	142
Reg. IV.....	70.49	132	157	180	214	173	152	167	166	164	163	159	155	154	145	133	126	122	125	126	127	137	132
Reg. V.....	76.66	133	158	179	218	171	153	168	167	163	164	160	156	156	148	137	129	125	129	128	131	141	137
Reg. VI.....	77.41	133	157	177	215	175	155	169	170	163	164	162	158	158	150	138	129	125	128	128	129	139	134
Reg. VII.....	75.62	131	157	175	212	177	158	170	170	165	166	163	160	158	151	139	131	128	130	129	131	140	135
Reg. VIII.....	78.15	133	160	176	208	173	157	171	171	166	167	164	161	161	154	143	133	130	133	134	135	144	141

(Indexes represent territorial index factors and are not necessarily applicable for determining unit reproduction costs upon individual roads.)

Railroad Cost Indexes by Accounts Applicable to Entire U. S., Regions I to VIII, Incl.

"Road" Construction	1917	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38
Engineering.....	134	159	178	214	175	157	171	171	166	166	164	161	160	152	143	131	127	131	131	133	142	138
Grading.....	130	165	190	250	170	143	160	164	149	153	143	135	133	123	118	106	98	100	101	99	103	93
Undergr'd Power Tubes..																						
Tunnels and Subways....	128	150	183	208	179	165	179	179	179	178	169	155	155	143	130	119	111	122	120	130	139	141
Bridges, Culverts, etc....	146	162	178	206	165	160	176	173	171	170	168	164	163	150	134	122	122	136	135	141	155	150
Elevated Structures.....	169	177	184	210	150	153	173	171	168	165	163	163	162	154	144	129	122	136	136	137	158	150
Ties.....	112	133	170	201	189	157	177	175	172	173	175	176	175	170	155	144	139	149	147	150	159	154
Rails.....	121	148	152	168	158	144	145	145	144	144	144	144	144	144	144	140	134	123	123	124	143	139
Other Track Material....	198	210	203	209	192	161	182	179	177	177	177	177	170	169	165	163	158	150	147	150	169	169
Ballast.....	114	140	150	207	191	176	175	175	174	175	176	176	176	168	159	146	146	141	139	140	143	143
Track Laying & Surfacing.	130	163	175	218	174	165	188	188	188	188	188	188	188	182	175	164	157	159	165	165	169	167
Right-of-way Fences.....	142	178	194	204	189	177	179	179	176	175	175	175	173	171	164	147	135	140	140	138	143	144
Snow, Sand Fences, Sheds.	119	165	199	280	197	194	212	200	201	201	204	204	204	198	188	125	126	140	140	140	155	155
Crossings and Signs.....	137	161	182	208	171	164	178	175	171	169	166	165	165	161	153	131	127	139	137	139	152	145
Station and Office Bldgs..	135	154	185	215	192	180	194	193	188	184	189	188	187	182	165	141	145	151	151	157	166	166
Roadway Buildings.....	136	156	185	216	192	178	196	196	189	187	192	191	190	186	166	140	145	150	150	150	162	162
Water Stations.....	159	170	191	213	185	178	187	187	186	182	185	186	184	177	161	147	151	155	155	156	166	166
Fuel Stations.....	153	160	190	212	181	166	185	185	182	180	183	183	183	174	159	144	149	154	154	153	159	159
Shops and Enginehouses..	141	159	188	216	191	180	193	192	188	185	189	188	187	176	161	137	142	147	147	155	165	165
Grain Elevators.....	128	150	185	214	190	184	197	197	193	190	195	193	193	182	165	137	142	147	147	156	164	164
Storage Warehouses.....	135	155	185	210	193	178	198	198	193	189	193	191	191	184	165	137	142	147	147	154	166	166
Wharves and Docks.....	133	152	178	204	167	158	175	175	174	177	178	178	178	172	158	136	141	146	146	149	153	153
Coal and Ore Wharves ..	145	155	184	204	170	159	176	176	174	174	176	176	176	172	157	136	142	147	147	151	153	153
Gas Producing Plants....	148	175	194	213	194	176	188	189	186	185	188	189	189	178	163	145	148	179	179	178	178	177
Telegraph & Teleph. Lns.	147	158	164	192	191	162	187	179	163	157	163	165	165	150	138	121	119	125	131	131	135	129
Signals and Interlockers..	132	152	165	175	163	158	165	164	162	169	158	155	154	147	138	130	130	133	136	138	143	143
Pwr Dams, Cnls, Pipe Lns																				151	149	149
Pwr Plant Buildings.....	141	158	189	218	197	184	196	196	191	186	191	191	189	177	162	138	143	148	148	152	167	167
Pwr Substa Bldgs.....	137	156	187	218	194	180	197	197	192	188	193	191	190	176	161	137	142	147	147	148	164	164
Pwr Transmn Sys.....	190	181	186	176	145	132	142	136	140	141	137	142	150	136	116	98	98	103	105	108	123	110
Pwr Dist Sys.....	178	192	189	205	172	163	178	172	175	176	175	178	181	173	148	144	144	148	151	152	155	149
Pwr Line Poles, Fixtrs....	145	169	194	230	208	179	209	203	185	183	198	199	209	200	172	147	147	150	153	148	157	152
Underground Conduits...	119	172	206	250	228	214	220	215	220	216	219	219	217	215	175	175	175	180	184	185	185	185
Misc. Structures.....	137	156	186	217	192	179	195	195	190	186	191	190	189	182	164	141	146	151	151	154	161	161
Paving.....	153	177	205	217	191	190	191	191	191	190	190	190	190	190	181	156	150	145	145	145	150	150
Roadway Machines.....	127	146	158	170	162	149	151	151	151	151	151	149	148	147	144	138	138	147	147	147	161	153
Roadway Small Tools....	179	179	184	202	181	170	173	185	190	190	191	191	190	160	155	155	150	150	150	160	170	180
Shop Machinery.....	155	192	200	210	198	173	183	185	185	186	187	189	191	176	166	155	155	179	179	179	198	200
Power Plant Machinery...	155	192	200	210	198	173	183	185	185	186	187	189	191	176	166	155	155	179	179	193	206	199
Power Substation Appar..	155	192	200	210	198	173	183	185	185	186	187	189	191	176	166	155	155	179	179	145	149	151

"SAMSON OF THE CIMARRON"

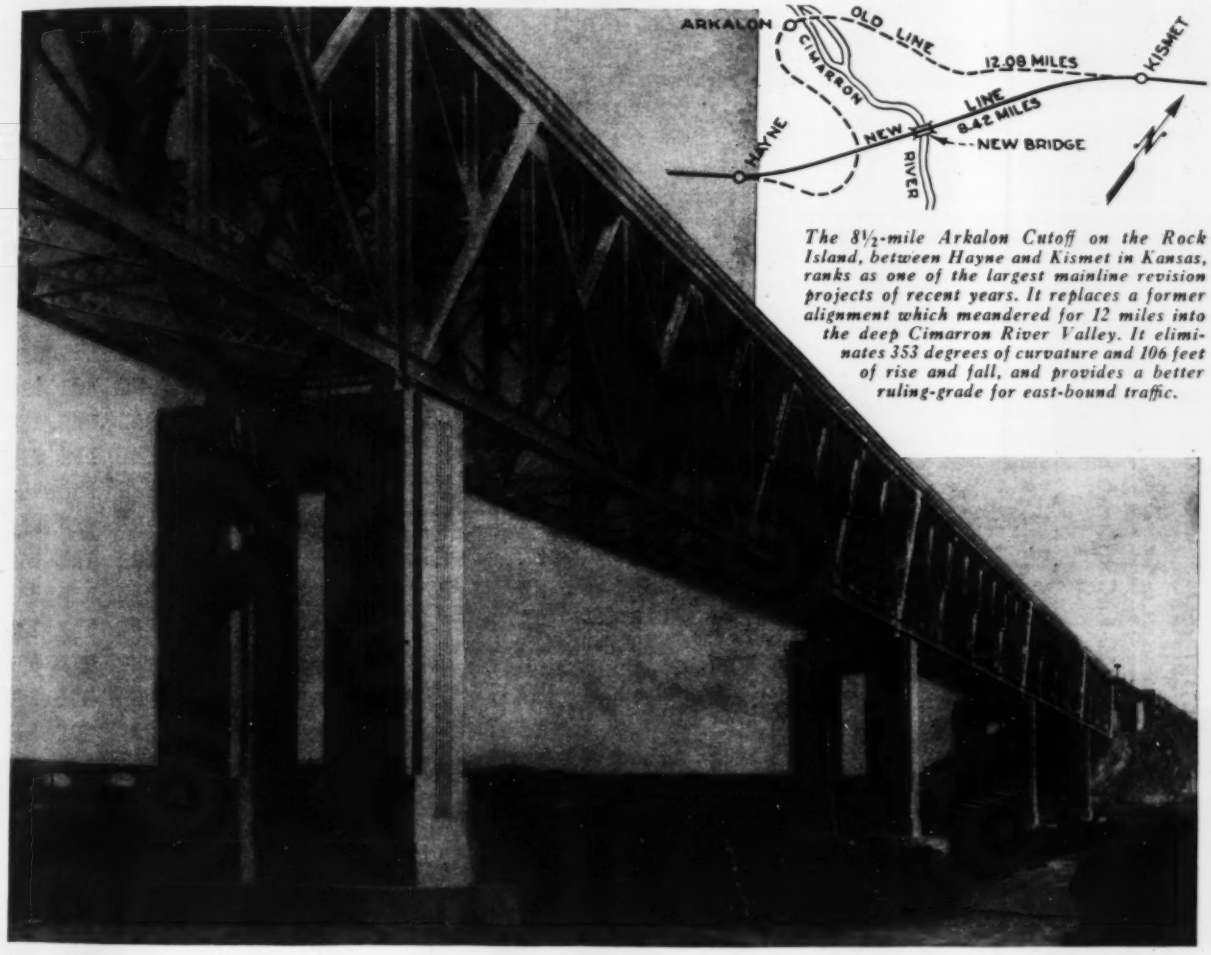
SIMPLE, FUNCTIONAL LINES EMPHASIZE ITS STURDINESS AND UTILITY

KEY structure of the recently completed Arkalon Cutoff on the Chicago, Rock Island & Pacific Railway, the "Samson of the Cimarron," ranks among the largest bridges on the Rock Island system; effectively illustrates how sturdiness and utility can be obtained along pleasingly functional lines.

This high-level bridge spans the bottoms of the Cimarron some two miles downstream from the old main-line crossing. With its track-deck 97 feet above the bed of the rampaging and unpredictable stream, it stands out in marked contrast to the former low-level pile-trestle crossing which involved hazardous and costly maintenance because of frequent washouts.

The 1269-foot single-track steel superstructure consists of five 250-foot deck truss spans. These spans are of the Warren subdivided panel type, 36 feet deep and spaced 18 feet on centers. Rows of CB bearing piles —834 tons of rolled shapes supplied by Carnegie-Illinois Steel Corporation—support the bridge seats and embankment walls at each U-shaped abutment.

This modern, streamlined structure, embodying many novel construction features, significantly justifies the thoughtful, cooperative planning and engineering on the part of the railroad's various departments. Coordinated with the speedy schedule to which the entire project was geared, the fabrication of the 2700 tons of structural steel involved was completed by American Bridge Company well within the specified time limit.



The 8½-mile Arkalon Cutoff on the Rock Island, between Hayne and Kismet in Kansas, ranks as one of the largest mainline revision projects of recent years. It replaces a former alignment which meandered for 12 miles into the deep Cimarron River Valley. It eliminates 353 degrees of curvature and 106 feet of rise and fall, and provides a better ruling-grade for east-bound traffic.

AMERICAN BRIDGE COMPANY

General Offices: Frick Building, Pittsburgh, Pa.

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Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

PUBLIC UTILITY CONSTRUCTION COST INDEX

Compiled and published by Whitman, Requardt and Smith, Consulting Engineers, Baltimore, Md., for the Estate of William W. Handy

Table No. 1 Cost Trends of Building Construction, 1911 to 1914 = 100

Complete Index reports 13 items entering into Building Construction Costs)

Classes of Construction Material and Labor Elements	1916	1917	1918	Jan. 1 1919	Jan. 1 1920	July 1 1920	Nov. 1 1920	Jan. 1 1921	Sept. 1 1921	Feb. 1 1922	Jan. 1 1923	Jan. 1 1924	July 1 1924	Jan. 1 1925	July 1 1925	Jan. 1 1926	July 1 1926	Jan. 1 1927	July 1 1927	Jan. 1 1928	July 1 1928	Jan. 1 1929	July 1 1929	Jan. 1 1930	July 1 1930	Jan. 1 1931	July 1 1931	Jan. 1 1932	July 1 1932	Jan. 1 1933	July 1 1933	Jan. 1 1934	July 1 1934	Jan. 1 1935	July 1 1935	Jan. 1 1936	July 1 1936	Jan. 1 1937	July 1 1937	Jan. 1 1938	July 1 1938	Jan. 1 1939	July 1 1939	Jan. 1 1940
Atlantic Seaboard Division																																												
Reinforced Concrete	153	233	242	237	238	274	269	233	182	165	199	227	224	221	216	213	213	214	203	204	206	209	212	205	194	189	179	171	159	153	165	178	194	191	189	191	192	199	216	214	205	205	207	210
Brick	141	192	212	220	248	279	278	245	207	188	215	237	232	230	229	228	229	230	223	224	217	219	220	212	207	203	194	189	173	166	175	189	200	195	194	197	197	203	218	217	211	211	214	217
North Central Division																																												
Reinforced Concrete	153	230	230	220	220	270	263	228	181	163	193	219	214	212	208	203	201	205	194	195	197	200	203	199	190	185	177	169	154	151	162	175	186	182	182	186	187	196	209	209	200	200	200	202
Brick	140	189	198	199	224	272	269	238	201	181	206	225	218	216	215	212	211	214	208	209	201	203	205	199	195	192	186	181	164	161	170	183	190	185	184	188	189	197	207	208	203	203	203	205
South Central Division																																												
Reinforced Concrete	155	232	236	224	224	268	263	229	181	160	191	213	206	203	196	192	191	194	186	185	188	191	193	187	179	176	159	149	144	140	148	160	173	179	173	175	177	187	200	198	188	188	187	189
Brick	142	191	204	203	228	271	270	240	224	181	206	221	211	208	205	203	204	205	201	202	195	197	198	190	185	183	168	160	154	151	157	171	179	182	175	178	180	198	198	197	191	191	191	193
Plateau Division																																												
Reinforced Concrete	151	232	234	221	220	260	256	221	181	164	192	215	208	208	201	198	197	199	188	189	191	194	196	190	180	177	166	153	149	146	156	168	178	174	172	176	180	188	206	203	194	194	194	197
Brick	139	191	203	202	226	264	264	232	203	185	207	223	214	214	211	211	210	211	205	205	199	200	201	193	187	184	175	167	163	160	168	182	187	182	181	182	185	191	206	204	199	199	200	201
Pacific Division																																												
Reinforced Concrete	151	230	233	220	225	266	259	226	187	165	191	212	205	203	196	191	190	196	185	185	188	191	194	188	178	175	165	157	148	145	153	166	177	174	173	175	178	186	200	199	192	192	192	194
Brick	138	189	201	199	229	268	265	234	207	185	204	217	206	205	201	198	197	203	197	197	190	192	194	186	180	177	169	164	156	154	156	170	177	172	173	176	179	185	198	197	193	193	193	195

Table No. 2 Cost Trends of Gas Plant Construction, 1911 = 100

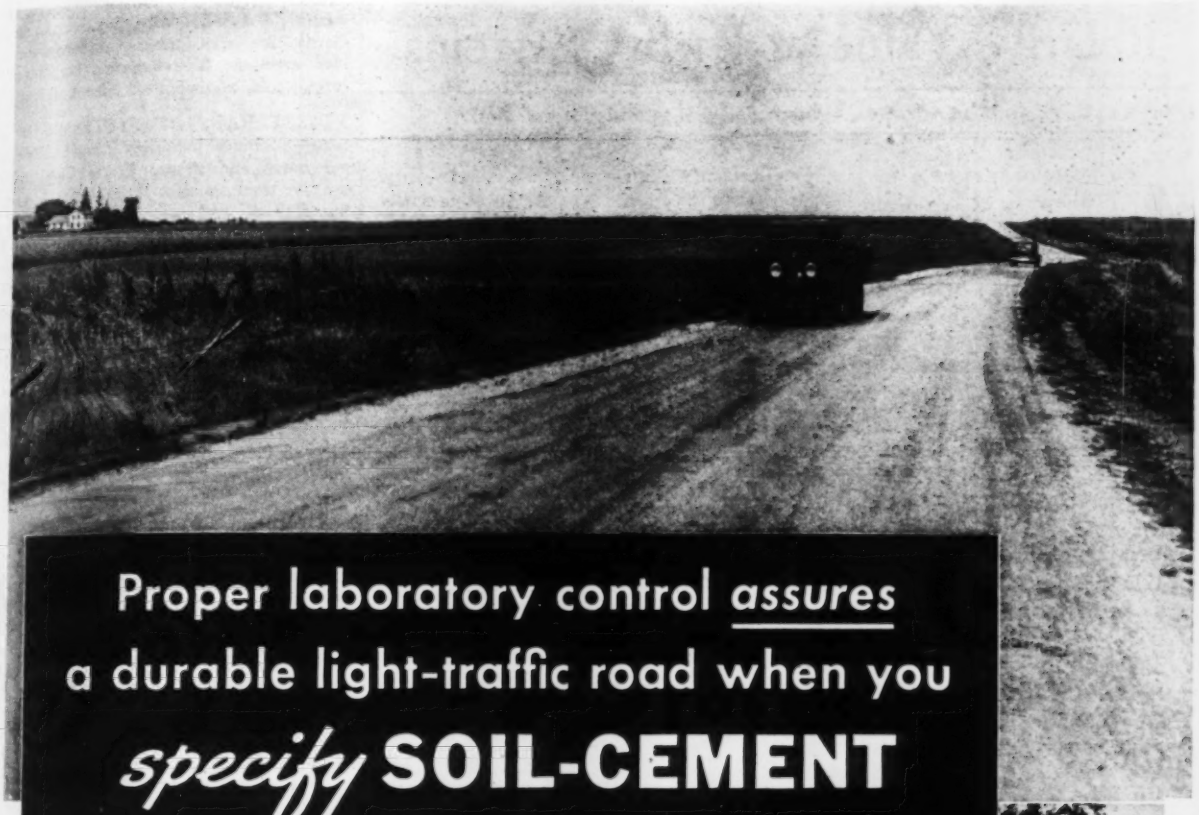
(Complete Index reports 17 items entering into Gas Plant Construction Costs) A, relates to Total Constr. & Equip; B relates to Mech. Equip. Excl. of Gas Holders

	1913	1914	1915	1916	1917	1918	Jan. 1 1919	Jan. 1 1920	July 1 1920	Jan. 1 1921	Sept. 1 1921	Jan. 1 1923	Jan. 1 1924	July 1 1924	Jan. 1 1925	July 1 1925	Jan. 1 1926	July 1 1926	Jan. 1 1927	July 1 1927	Jan. 1 1928	July 1 1928	Jan. 1 1929	July 1 1929	Jan. 1 1930	July 1 1930	Jan. 1 1931	July 1 1931	Jan. 1 1932	July 1 1932	Jan. 1 1933	July 1 1933	Jan. 1 1934	July 1 1934	Jan. 1 1935	July 1 1935	Jan. 1 1936	July 1 1936	Jan. 1 1937	July 1 1937	Jan. 1 1938	July 1 1938	Jan. 1 1939	July 1 1939	Jan. 1 1940
Atlantic Seaboard Division																																												
A	106	107	112	136	186	229	239	253	279	265	205	224	241	238	234	229	230	230	226	223	215	216	216	219	218	216	214	208	202	188	176	178	189	216	216	217	218	218	225	246	246	244	241	249	253
B	100	104	108	138	195	233	219	222	241	248	201	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274	278	282
North Central Division																																												
A	103	102	109	131	180	203	210	221	257	248	201	206	226	224	220	217	217	218	214	211	204	205	204	206	207	208	207	203	198	178	182	185	196	203	202	203	208	208	219	235	237	235	232	232	236
B	100	104	108	138	195	233	219	222	241	248	201	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274	278	282
South Central Division																																												
A	103	102	114	145	182	213	214	223	251	246	203	196	214	210	205	199	199	200	198	195	187	187	187	190	188	187	185	177	171	160	158	167	177	184	195	196	202	202	208	223	222	219	216	217	220
B	100	104	108	138	195	233	219	222	241	248	201	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274	278	282
Plateau Division																																												
A	103	103	107	128	180	207	207	214	234	231	194	193	210	206	206	201	202	202	198	195	187	189	189	191	189	188	186	181	176	166	170	173	184	191	190	190	195	195	202	221	221	220	216	217	220
B	100	104	108	138	195	233	219	222	241	248	201	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274	278	282
Pacific Division																																												
A	104	102	107	128	180	207	209	228	255	248	212	203	219	215	211	206	205	206	206	203	196	197	197	201	200	198	197	191	187	177	180	178	189	196	195	197	198	203	210	228	228	230	227	228	232
B	100	104	108	138	195	233	219	222	241	248	201	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274	278	282

Table No. 3 Cost Trends of Electric Light and Power Construction, 1911 = 100

Complete Index reports 50 items entering into Electric Light and Power Construction Costs)

Classes of Constr. Material, Equipment and Labor Elements	1914	1915	1916	1917	1918	Jan. 1 1919	Jan. 1 1920	July 1 1920	Jan. 1 1921	Sept. 1 1921	Jan. 1 1923	Jan. 1 1924	July 1 1924	Jan. 1 1925	July 1 1925	Jan. 1 1926	July 1 1926	Jan. 1 1927	July 1 1927	Jan. 1 1928	July 1 1928	Jan. 1 1929	July 1 1929	Jan. 1 1930	July 1 1930	Jan. 1 1931	July 1 1931	Jan. 1 1932	July 1 1932	Jan. 1 1933	July 1 1933	Jan. 1 1934	July 1 1934	Jan. 1 1935	July 1 1935	Jan. 1 1936	July 1 1936	Jan. 1 1937	July 1 1937	Jan. 1 1938	July 1 1938	Jan. 1 1939	July 1 1939	Jan. 1 1940
Atlantic Seaboard Division																																												
Tot. Constr. & Equip.	102	106	132	160	192	202	208	226	221	183	189	201	196	201	197	197	194	193	187	192	192	195	206	204	188	191	188	182	176	170	177	186	200	200	199	204	205	213	230	226	222	224	225	232
Elec. Plant — Steam	102	106	119	132	160	187	196	206	216	194	186	195	192	199	196	197	196	194	190	193	192	200	208	206	198	198	195	192	186	182	186	200	205	205	204	208	209	210	229	228	223	225	224	235
Sub-Sta. Equip	102	105	111	130	161	178	175	197	201	182	176	187	186	191	190	184	178	176	172	173	173	170	181	179	174	177	175	172	168	165	166	172	184	184	184	185	187	188	204	204	203	203	203	212
North Central Division																																												
Tot. Constr. & Equip.	100	105	129	154	178	184	189	214	210	176	179	193	189	194	192	190	187	187	182	186	186	189	199	199	184	188	187	186	174	172	179	187	195	195	194	199	199	209	224	222	216	219	218	222
Elec. Plant — Steam	100	102	112	123	145	163	172	188	197	179	171	185	185	189	189	189	188	188	185	188	187	195	202	203	195	197	199	199	186	186	189	203	204	203	202	204	205	209	227	225	222	224	223	225
Sub-Sta. Equip	100	102	104	122	145	155	151	180	184	167	162	178	179	182	184	178	171	171	168	169	169	167	177	176	172	177	179	181	169	169	171	176	184	184	184	184	184	187	204	203	202	203	202	203
South Central Division																																												
Tot. Constr. & Equip.	100	107	130	157	183	188	193	218	216	183	182	193	186	189	186	184	183	182	179	183	186	189	199	197	185	186	183	179	171	169	179	187	195	198	193	199	201	208	224	221	216	218	218	223
Elec. Plant — Steam	100	104	114	127	152	169	178	197	210	188	181	190	186	189	186	187	189	187	186	189	195	202	210	209	205	204	203	200	190	189	198	211	212	212	203	208	212	214	234	232	229	231	230	235
Sub-Sta. Equip	100	103	107	125	152	160	157	189	195	176	172	182	181	181	181	175	171	170	169	170	176	174	184	182	182	184	183	181	173	173	179	185	192	192	184	188	191	192	211	210	209	210	209	213
Plateau Division																																												
Tot. Constr. & Equip.	100	103	128	155	183	187	189	211	209	178	179	192	186	191	191	190	188	186	181	185	185	188	198	197	181	183	181	177	171	169	179	188	196	196	195	198	198	206	225	215	210	210	210	220
Elec. Plant — Steam	100	101	114	125	153	171	175	192	202	186	178	191	189	191	194	197	196	194	190	193	193	200	208	207	199	198	197	194	188	188	197	211	212	211	210	210	210	214	235	221	218	220	220	230
Sub-Sta. Equip	100	100	106	124	154	162	154	184	187	173	168	184	183	184	188	185	177	176	172	173	173	171	182	179	175	177	177	175	171	171	177	183	191	191	191	189	189	189	210	209	208	209	211	212
Pacific Division																																												
Tot. Constr. & Equip.	100	103	127	156	178	182	194	214	214	185	178	187	182	185	182	180	178	181	175	180	179	182	192	191	176	178	175	172	163	161	170	178	189	189	192	196	197	204	221	218	214	218	215	219
Elec. Plant — Steam	100	101	111	127	145	161	179	192	206	191	172	180	178	178	177	182	178	181	180	187	195	193	186	186	185	182	170	170	170	168	191	198	197	203	204	204	206	226	226	223	221	222	223	222
Sub-Sta. Equip	100	100	104	126	146	163	160	184	193	180	163	174	173	174	173	167	161	165	162	163	163	161	171	168	165	167	166	164	155	155	161	166	179	179	179	184	185	186	204	203	202	203	202	203



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Near Johnsonville, South Carolina. Applying moisture in exact amount as shown to be required by laboratory control tests.

Wayne County, Iowa. Soil-cement mixing operation, using a field cultivator.

(top of page)
Soil-cement secondary road in Winnebago County, Illinois.

Relative Value of Utility Systems

C. F. Lambert, Utility Engineer and Consultant, Miami, Fla.

THIS RECORD brings up to Jan. 1, 1940, values of five utilities originally published in *Engineering News-Record*, May 7, 1925 and brought up to date annually in *Construction Costs*, 1931 to 1937.

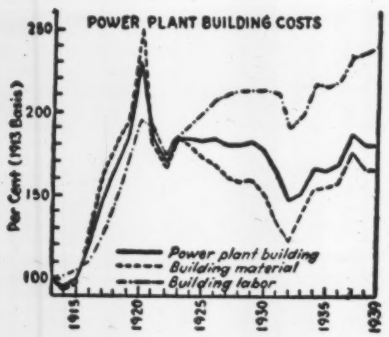
In computing each of these five utility value trends, additional plants have been added until about twice as many are now used as originally. The trend in equipment as well as in prices is thus followed. Values for each year are the average for the entire year.

Definition of the items used in computing these price trends is shown for each utility in the accompanying summary.

Table II shows values on a 1926 base, Table III on a 1913 base. Charts on the opposite page illustrate comparable annual values of all five utilities as well as the annual average trend, the preceding 5- and the preceding 10-year average trends, while Table I gives the 1939 monthly values which also are charted in an adjacent column to demonstrate the slight rise that occurred in the last half of the year. Power plant building values with labor and materials trends are charted separately on this page.

Summary of Data Covered

POWER PLANT BUILDINGS: 50 buildings—Relative values shown by chart only, labor and material trends shown separately. *Building* items include cement in both plain and reinforced concrete, sand, crushed rock,



brick, reinforcing steel, structural steel, roofing, sheet metal, windows, doors, heating material, electric lighting, common labor, carpenters, bricklayers, structural iron workers, metal workers, roofers and electricians.

WATERWORKS: 25 systems 68 items including *Land*, entirely a local matter (study indicates that the most accurate relation of land to other values is obtained by keeping land unit the same throughout the period); *Buildings; Equipment*, boilers, stokers, boiler settings, pumps, motors, steam pumps, condensers, steam piping, miscellaneous equipment, erection; *Distribution*, cast iron pipe, steel pipe, wood pipe, valves, hydrants, meters, standpipes, reservoirs, filter plants, labor; *Miscellaneous*, furniture, fixtures, tools, automobiles, miscellaneous.

ELECTRIC LIGHT PLANTS: 25 plants—84 items including *Land; Buildings; Equipment*, boilers, stokers, steam piping, auxiliary equipment, engines, turbines, diesels, condensers, generators, switchboards; *Distribution*, substation equipment, transformers, lighting equipment, [illegible], conductors, hardware, wire, insulators, meters, distribution transformers, underground cables, erection; *Miscellaneous*, furniture, fixtures, tools, automobiles, miscellaneous.

STREET RAILWAY SYSTEMS: 10 systems—82 items including *Land*; *Buildings*, car barns and shops; *Track Construction*, tangent track, special layouts, grading, paving, concrete and steel bridges, rails, spikes, bolts, ties, labor; *Span Construction*, poles, conductors, pole hardware, copper, erection; *Cars & Equipment; Miscellaneous*, furniture, fixtures, tools, automobiles, miscellaneous. Power plant buildings excluded because power is so frequently purchased from separate department or company.

NATURAL GAS PLANTS: 15 systems—58 items including *Land; Buildings; Equipment*, holders, small pumps, miscellaneous; *Distribution*, cast iron pipe, steel pipe, regulators, governors, valves, meters; *Miscellaneous*, furniture, fixtures, tools, autos.

MANUFACTURED GAS SYSTEMS: 25 plants—63 items including *Land; Buildings; Equipment*, boilers, gas machinery holders, miscellaneous; *Distribution*, cast iron pipe, steel pipe, regulators, valves, meters; *Miscellaneous*, furniture, fixtures, tools, autos.

Table I—Relative Monthly Value For 1939 with 1913 = 100

	Water Works	Electric Light	Street Ry.	Natural Gas	Artificial Gas
Jan.	188.6	180.8	162.5	181.7	192.5
Feb.	188.8	180.9	162.6	181.8	192.6
Mar.	188.7	180.9	162.7	181.7	192.5
Apr.	188.8	180.3	162.6	181.8	192.6
May	188.6	179.2	162.0	181.7	192.7
June	188.4	179.1	161.5	181.5	192.2
July	188.4	179.4	161.7	181.6	192.3
Aug.	188.5	179.5	161.7	181.6	192.3
Sept.	188.7	181.5	162.0	181.7	192.6
Oct.	194.0	183.5	163.0	182.9	194.5
Nov.	194.4	184.2	163.5	183.0	194.7
Dec.	194.5	184.1	163.9	183.0	194.7
Average	189.8	181.1	162.3	182.0	193.0

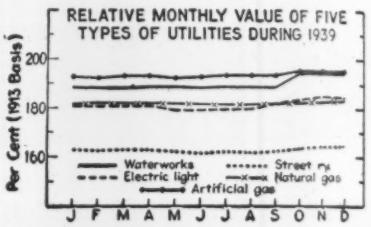


Table II—Relative Yearly Utility Values Based on 1926 Costs—Lambert

	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Water Works Plants															
A	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
B	10.9	11.0	10.7	10.6	10.8	10.5	9.6	8.8	9.0	9.9	9.9	10.1	11.3	10.9	10.9
C	12.1	12.0	11.9	12.2	12.3	11.8	11.1	10.3	11.1	12.1	12.0	12.1	13.6	13.1	13.0
D	75.8	74.4	67.5	65.6	69.8	68.9	65.2	59.7	62.3	68.7	69.4	69.9	76.9	75.6	74.4
E	1.1	1.1	1.0	1.0	1.0	1.0	.8	.7	.9	.9	.9	.9	1.0	1.0	1.0
T	101.4	100.0	92.6	90.9	95.4	93.7	88.2	81.0	84.8	93.1	93.7	94.5	104.3	102.1	100.8
Electric Light Plants															
A	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
B	10.8	10.8	10.6	10.6	10.8	10.3	9.6	8.7	8.8	9.8	9.8	10.0	11.1	10.7	10.7
C	42.9	42.5	41.9	42.5	43.9	41.4	38.8	35.5	38.5	43.4	43.1	43.3	48.0	46.9	46.2
D	41.3	41.6	41.4	42.5	44.2	42.0	39.2	34.5	36.0	41.1	40.6	41.3	46.5	43.8	44.5
E	3.6	3.5	3.3	3.3	3.3	3.2	2.9	2.6	2.7	2.9	2.9	2.9	3.2	3.1	3.0
T	100.2	100.0	98.8	100.5	103.8	98.5	92.1	82.9	87.6	98.8	98.0	99.1	110.4	106.1	106.0
Street Railway Systems															
A	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
B	5.0	5.0	4.9	4.9	4.9	4.8	4.4	3.9	4.1	4.5	4.5	4.6	5.1	5.0	5.0
F	63.6	63.6	62.7	62.6	61.7	60.4	57.9	53.5	54.2	56.5	55.5	56.0	60.9	59.0	58.4
G	23.5	23.5	23.5	23.0	23.0	23.1	19.6	18.6	17.8	20.7	21.0	21.6	24.0	23.4	22.8
H	4.7	4.6	4.7	4.8	5.0	4.8	4.5	4.0	4.0	4.3	4.3	4.5	4.7	4.5	4.4
E	1.8	1.8	1.8	1.7	1.7	1.7	1.5	1.4	1.4	1.6	1.6	1.6	1.8	1.7	1.7
T	100.1	100.0	99.1	98.5	97.8	96.3	89.4	82.9	83.0	89.1	88.4	89.8	98.0	95.1	93.8
Natural Gas Plants															
A	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
B	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.3	1.3	1.4	1.4	1.4	1.6	1.6	1.6
C	1.6	1.6	1.6	1.6	1.5	1.5	1.4	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1.8
D	93.3	93.0	90.6	90.8	91.2	89.9	87.5	82.7	83.2	90.0	89.4	86.1	92.8	91.3	89.6
E	2.9	2.9	2.8	2.8	2.8	2.8	2.6	2.3	2.3	2.4	2.4	2.4	2.6	2.6	2.5
T	100.3	100.0	97.4	97.6	97.9	96.6	93.8	88.5	89.1	96.2	95.7	92.5	99.7	98.2	96.4
Artificial Gas Systems															
A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
B	6.6	6.7	6.5	6.4	6.6	6.4	5.9	5.4	5.5	6.1	6.1	6.2	6.9	6.6	6.6
C	32.2	32.3	32.1	31.6	31.2	28.7	26.2	25.2	27.4	30.6	31.3	31.8	37.1	37.3	37.0
D	57.1	56.8	54.0	53.8	55.3	54.6	53.2	49.3	49.5	54.3	54.3	53.4	57.3	56.4	55.4
E	2.1	2.0	2.0	2.0	2.0	1.9	1.8	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8
T	100.2	100.0	96.8	96.0	97.3	93.8	89.3	83.7	86.1	94.9	95.6	95.3	105.3	104.3	103.0

A—Land. B—Buildings. C—Equipment. D—Distribution. E—Miscellaneous. F—Track Construction. G—Cars and Equipment. H—Span Construction. T—Total.

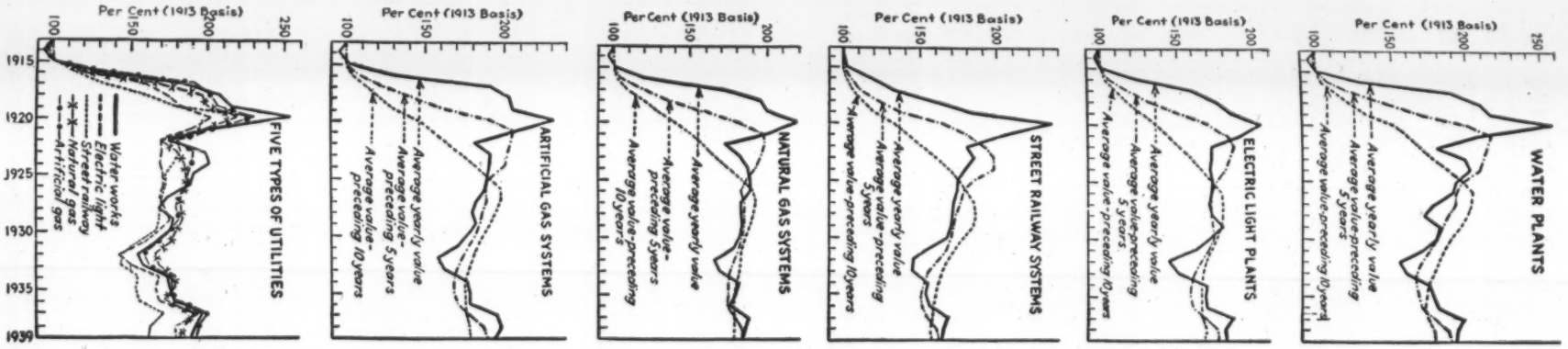


Table III—Relative Yearly Value of Main Items Entering Into Physical Value of Five Utilities 1913-1939—1913=100—Lambert

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Waterworks Plants																											
Land	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Bldgs	11.2	10.8	11.1	13.3	16.5	18.5	20.6	25.6	20.9	19.0	20.8	20.7	20.6	20.7	20.2	20.1	20.4	19.7	18.2	16.6	16.9	18.7	18.6	18.9	20.9	20.5	20.6
Equip	12.1	12.0	14.0	17.3	22.6	23.4	24.3	26.0	23.4	21.8	22.9	23.0	22.9	22.7	22.5	23.0	23.2	22.3	20.9	19.5	21.0	22.9	22.5	22.7	25.0	24.7	24.3
Distr	72.7	67.1	71.3	94.1	143.2	161.1	165.8	197.8	155.8	130.1	149.8	152.2	143.2	140.5	127.5	123.8	131.8	130.0	123.3	112.6	116.8	129.7	130.7	131.8	144.8	142.7	140.2
Misc	1.1	1.1	1.2	1.4	1.8	2.0	2.3	2.8	2.2	2.0	2.2	2.0	2.1	2.0	1.9	1.9	1.9	1.9	1.6	1.4	1.6	1.7	1.7	1.7	1.9	1.8	1.8
Total	100.0	93.9	100.5	129.0	187.0	207.9	215.9	255.1	205.2	175.8	198.6	200.8	191.7	188.8	175.0	171.7	180.2	176.8	166.9	153.0	159.2	175.9	176.4	178.0	195.5	192.6	189.8
Electric Light Plants																											
Land	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Bldgs	10.1	9.7	10.0	12.0	14.9	16.7	18.5	23.1	19.9	17.1	18.8	18.6	18.5	18.6	18.2	18.2	18.5	17.8	16.5	14.9	15.2	16.8	16.7	17.0	18.8	18.4	18.5
Equip	38.9	36.7	36.7	47.9	73.5	79.5	81.0	86.7	84.6	75.1	73.4	73.5	73.6	73.0	72.0	72.9	75.4	71.0	66.6	60.9	66.2	75.5	73.9	74.3	82.2	80.2	79.0
Distr	44.8	43.5	47.1	56.1	63.4	69.6	75.2	82.6	77.4	70.4	70.4	69.6	70.9	71.2	71.1	72.9	75.8	71.7	67.1	59.4	61.8	70.3	69.2	70.3	79.3	74.6	75.7
Misc	3.4	3.4	3.4	4.1	5.1	6.0	6.8	8.6	6.8	6.2	6.2	6.1	6.1	6.0	5.7	5.6	5.6	5.5	5.0	4.5	4.6	4.9	4.9	4.9	5.3	5.2	5.1
Total	100.0	96.1	100.0	122.9	159.7	174.6	184.3	203.8	191.5	171.6	171.6	170.6	171.9	171.6	169.8	172.4	178.1	168.8	158.0	142.5	150.6	169.3	167.5	169.3	188.4	181.2	181.1
Street Railway Systems																											
Land	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Bldgs	4.7	4.5	4.6	5.6	6.9	7.8	8.6	10.8	8.8	8.0	8.8	8.7	8.6	8.6	8.5	8.5	8.6	8.3	7.6	6.9	7.1	7.8	7.8	7.9	8.8	8.5	8.5
Trk. Catr.	64.3	63.1	63.4	71.9	83.3	104.8	113.8	144.1	119.9	105.4	113.6	112.8	110.2	110.2	108.6	108.5	106.9	104.7	100.1	92.9	94.1	97.9	96.0	96.9	104.6	102.2	101.2
Span. Catr.	5.8	5.4	6.3	8.7	9.9	9.7	10.0	11.1	9.0	8.5	8.7	8.8	8.1	8.0	8.1	8.4	8.7	8.4	7.8	7.0	7.0	7.5	7.4	7.7	8.2	7.8	7.7
Cars. eq	20.9	22.4	22.8	25.1	27.2	31.1	44.4	61.1	59.1	53.0	47.0	42.9	40.7	40.7	40.7	39.9	39.9	39.9	34.0	32.4	30.8	35.8	36.4	37.3	41.6	40.5	39.4
Misc	1.7	1.6	1.6	2.2	2.9	3.2	3.5	4.3	3.6	3.2	3.3	3.2	3.2	3.2	3.1	3.0	3.0	3.0	2.7	2.5	2.5	2.7	2.7	2.7	3.0	3.0	2.9
Total	100.0	99.6	101.3	116.1	132.8	159.2	182.9	234.0	203.0	180.7	184.0	179.0	173.4	173.3	171.6	170.9	169.7	166.9	154.8	144.3	144.1	154.3	152.9	155.1	168.8	164.6	162.3
Natural Gas Plants																											
Land	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Bldgs	1.6	1.5	1.6	1.9	2.4	2.6	2.9	3.7	3.0	2.7	2.9	2.9	3.0	3.0	2.9	2.9	2.9	2.8	2.6	2.4	2.4	2.7	2.7	2.7	3.0	3.0	3.0
Equip	1.7	1.6	1.8	2.6	4.0	3.6	3.5	4.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	2.9	2.8	2.6	2.4	2.7	2.9	2.9	3.0	3.3	3.3	3.3
Distr	92.2	89.9	92.0	111.0	155.7	182.9	186.5	202.4	187.3	158.4	168.7	173.2	175.0	174.6	169.9	170.3	171.1	168.8	164.7	155.0	157.8	169.0	168.2	163.0	175.5	172.6	169.4
Misc	2.9	2.8	2.9	3.3	4.4	5.1	5.8	7.8	6.4	5.6	5.9	5.7	5.5	5.4	5.3	5.2	5.2	5.2	4.8	4.3	4.2	4.5	4.4	4.4	4.9	4.8	4.7
Total	100.0	97.4	99.9	120.4	168.1	195.8	200.3	219.6	201.4	171.4	182.2	186.5	188.1	187.6	182.7	183.0	183.7	181.2	176.3	165.7	168.7	180.7	179.8	174.7	188.3	185.3	182.0
Artificial Gas Systems																											
Land	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Bldgs	6.8	6.5	6.7	8.1	10.0	11.2	12.5	15.5	12.7	11.5	12.6	12.5	12.4	12.5	12.2	12.1	12.4	12.0	11.1	10.1	10.3	11.3	11.3	11.5	12.7	12.4	12.4
Equip	30.4	29.1	33.1	49.9	76.4	68.7	67.2	75.9	66.1	62.8	63.4	61.2	60.5	60.6	60.3	59.4	58.7	53.9	49.2	47.2	51.4	57.4	58.3	59.2	68.7	69.1	68.6
Distr	56.5	54.4	55.6	68.1	98.3	114.8	116.5	130.4	115.6	98.2	107.5	108.6	107.3	106.7	101.5	101.0	103.8	102.6	99.7	92.5	93.8	102.1	102.0	100.3	108.0	106.2	104.4
Misc	2.1	2.1	2.1	2.5	3.1	3.6	4.1	5.5	4.6	4.1	4.2	4.0	3.9	3.8	3.8	3.7	3.7	3.7	3.5	3.0	3.1	3.2	3.2	3.2	3.5	3.5	3.4
Total	100.0	96.3	101.7	132.8	192.0	202.5	204.5	231.5	203.2	180.8	191.9	190.5	188.3	187.8	182.0	180.4	182.8	176.4	167.7	157.0	162.8	178.2	179.0	178.4	197.1	195.4	193.0

Boeckh Index of Construction Costs — U. S. Average, 1926–'29 = 100

Annual Averages By Cities	Residences		Apartments, Hotels, Office Bldgs.			Commercial & Factory Bldgs.				
	Frame	Brick	Brick and Wood	Brick and Conc.	Steel	Frame	Steel	Brick and Wood	Brick and Steel	Brick and Conc.
ATLANTA AREA										
1926–29	82.7	87.0	84.2	83.7	87.0	82.9	94.5	84.7	87.5	86.8
1913	41.2	43.7	42.4	43.3	45.6	40.6	45.2	43.0	44.3	43.0
1915	41.0	43.6	42.0	43.3	44.7	40.1	44.3	42.8	43.7	43.8
1916	46.0	48.9	48.9	52.6	55.5	44.8	66.9	48.4	57.6	53.8
1917	54.4	57.2	56.6	63.7	69.4	46.0	90.6	56.6	74.4	63.9
1918	71.3	74.8	72.7	74.6	80.1	69.7	93.2	72.4	80.7	75.4
1919	103.6	05.1	00.6	87.0	95.0	05.5	95.3	96.1	90.9	86.5
1920	137.1	139.6	133.1	10.6	119.6	140.6	111.8	129.6	08.5	111.0
1921	85.1	188.1	183.9	181.9	84.0	184.5	75.6	82.2	176.8	84.0
1922	83.4	85.8	81.8	79.6	82.2	83.6	73.1	79.5	74.6	80.6
1923	88.6	92.8	89.1	88.9	91.5	88.3	86.7	88.0	86.1	91.9
1924	85.0	89.8	89.2	91.1	91.9	88.8	88.8	88.3	89.8	94.7
1925	81.7	86.5	85.6	88.6	88.6	85.3	89.4	85.1	83.4	92.5
1926	83.1	87.1	83.7	85.1	86.4	82.1	93.4	84.5	86.6	85.1
1927	82.4	85.9	83.6	83.2	84.6	81.8	96.5	84.2	85.5	85.6
1928	85.6	89.4	86.7	86.0	87.9	84.8	93.3	85.7	88.5	86.6
1929	79.7	85.6	82.8	80.5	88.2	82.9	94.8	84.4	89.4	89.9
1930	80.9	85.3	82.8	84.5	85.7	78.2	91.8	83.6	83.6	86.1
1931	78.6	82.8	80.2	80.4	80.4	77.2	82.2	81.6	80.4	82.1
1932	71.0	75.2	73.6	77.2	77.0	68.7	80.8	77.4	78.1	78.3
1933	64.6	69.6	68.3	77.9	76.1	62.7	79.5	71.8	79.0	82.0
1934	70.6	76.6	74.6	83.8	83.4	68.9	91.5	78.5	86.4	87.4
1935	68.4	72.4	73.2	83.9	82.6	64.9	89.7	77.7	85.6	87.6
1936	68.4	72.4	73.2	84.4	83.3	65.8	89.7	77.8	85.8	87.1
1937	79.0	85.1	82.8	92.7	92.2	76.7	97.9	85.7	93.7	95.2
1938	81.6	85.0	85.2	95.9	96.2	79.5	100.5	87.4	96.9	98.1
1939	82.8	86.0	86.1	95.1	95.0	80.6	96.2	88.6	94.6	97.4
BALTIMORE AREA										
1926–29	107.2	112.0	107.6	100.6	100.7	106.3	95.5	106.8	96.8	101.2
1935	80.0	85.5	82.7	89.9	87.3	78.1	87.6	85.5	88.1	90.6
1936	80.9	85.8	82.4	89.4	88.0	80.0	88.4	86.5	88.3	90.3
1937	88.8	93.2	90.4	93.4	93.8	87.9	97.0	91.8	95.4	93.0
1938	91.9	94.8	94.1	98.0	98.0	91.7	100.4	95.6	99.5	98.5
1939	93.5	95.5	95.6	99.3	99.2	94.0	101.7	96.6	101.4	100.2
BOSTON AREA										
1926–29	116.3	120.3	115.4	106.2	107.0	118.8	106.3	112.5	108.7	105.8
1935	91.2	97.6	94.5	98.2	95.3	90.8	98.5	95.0	100.4	101.1
1936	87.9	94.2	90.8	96.3	93.9	87.3	98.5	92.9	98.6	98.1
1937	103.3	110.5	106.6	111.6	109.2	103.5	112.1	107.6	114.4	113.2
1938	104.1	109.4	107.8	114.5	111.9	103.8	113.9	109.1	117.0	116.4
1939	106.2	110.4	110.1	116.3	113.7	105.7	114.2	111.5	118.2	118.5
CHICAGO AREA										
1926–29	109.2	114.2	109.8	113.2	109.1	112.9	105.2	105.9	112.9	116.0
1935	91.5	97.9	92.4	103.8	98.2	93.0	99.8	92.4	102.4	109.4
1936	97.2	102.9	97.8	110.0	103.9	100.4	105.0	96.6	109.7	115.9
1937	104.8	110.7	105.9	116.9	111.8	108.3	109.1	104.0	115.3	120.8
1938	107.9	110.6	109.5	122.7	117.8	111.5	117.9	108.0	122.4	126.7
1939	110.6	112.5	111.1	123.6	118.7	114.2	117.6	109.3	122.6	127.6
CINCINNATI AREA										
1926–29	100.5	105.0	101.3	101.0	100.2	100.2	99.6	103.1	100.6	101.0
1935	86.4	92.3	89.1	93.5	91.5	83.7	92.9	92.8	94.9	94.5
1936	84.5	89.9	87.7	93.2	90.8	81.9	92.6	91.8	92.6	93.3
1937	98.8	106.1	102.9	107.5	105.3	98.2	107.9	104.7	109.1	109.7
1938	100.4	105.1	104.0	112.4	109.2	100.0	111.7	106.0	113.4	114.8
1939	103.3	106.2	105.9	113.9	110.4	103.3	111.7	107.1	113.7	116.5
CLEVELAND AREA										
1926–29	107.2	113.4	108.5	111.3	108.3	109.0	103.0	107.2	110.5	114.8
1935	87.6	94.5	90.9	96.7	93.5	87.5	94.9	91.7	98.2	100.3
1936	91.7	98.8	94.7	100.0	95.1	92.3	98.1	94.0	101.2	100.3
1937	105.1	112.3	107.7	112.5	109.1	106.5	110.6	108.1	114.8	116.3
1938	105.8	109.8	109.4	115.5	112.8	107.0	113.0	109.9	118.1	118.3
1939	106.2	109.6	109.5	115.3	112.8	107.5	112.9	109.5	117.7	118.0
DALLAS AREA										
1926–29	112.8	115.8	111.0	102.2	103.4	114.7	104.6	106.7	103.1	102.4
1935	82.8	88.9	86.3	85.1	85.1	79.5	84.8	90.8	81.5	84.9
1936	82.5	87.1	84.1	84.5	84.8	81.4	88.0	85.8	86.9	85.1
1937	89.9	95.2	92.2	92.0	94.2	88.5	95.0	94.4	94.1	92.3
1938	91.2	92.6	92.7	95.5	96.6	89.7	102.5	93.6	98.1	94.8
1939	95.1	95.8	96.7	98.8	100.2	94.8	106.6	96.0	101.9	98.9
DETROIT AREA										
1926–29	103.3	108.4	104.3	102.9	102.4	103.7	103.1	103.5	103.5	104.4
1935	78.1	83.4	81.0	88.1	87.1	77.5	92.6	81.8	90.5	90.2
1936	80.6	85.9	84.1	91.9	90.2	80.5	95.9	84.2	95.2	95.3
1937	93.9	100.7	97.3	103.4	101.7	94.3	107.0	97.6	107.4	106.5
1938	97.1	101.8	101.8	108.7	107.3	96.9	110.3	102.9	112.5	110.5
1939	98.8	102.7	102.9	108.6	107.5	98.7	108.8	104.2	111.4	110.1
MINNEAPOLIS AREA										
1926–29	92.8	98.2	94.6	95.6	96.1	92.8	100.0	93.9	97.9	98.4
1935	82.7	88.6	85.7	85.9	86.6	80.2	90.2	88.9	87.7	89.5
1936	88.6	93.6	89.2	92.6	91.6	88.7	96.1	89.2	94.3	95.7
1937	101.6	107.6	104.2	108.6	106.8	103.0	111.7	101.8	111.6	112.1
1938	101.2	105.5	103.9	113.4	111.2	102.1	114.7	103.3	115.2	117.2
1939	101.9	105.0	104.2	113.5	110.7	102.7	113.4	103.6	114.5	117.2
NEW ORLEANS AREA										
1926–29	93.3	96.3	93.4	86.5	90.6	93.3	93.7	91.5	89.5	86.5
1935	76.2	81.3	89.2	81.8	83.4	73.6	88.7	79.7	84.2	82.5
1936	73.4	78.8	76.6	81.8	83.2	70.4	88.9	77.6	83.7	82.6
1937	83.4	87.0	84.7	86.6	89.9	82.6	98.1	84.4	91.6	85.6
1938	86.3	87.5	88.5	92.2	95.6	85.0	102.0	88.3	96.0	91.5
1939	89.0	90.3	91.3	95.4	98.3	88.1	102.8	91.7	98.5	94.9
PHILADELPHIA AREA										
1926–29	100.3	107.6	103.7	105.9	103.1	98.1	96.3	106.2	102.2	108.8
1935	85.4	91.9	88.6	91.3	89.3	82.7	83.4	92.1	88.9	94.7
1936	88.7	95.5	93.0	96.5	92.6	85.7	91.7	97.2	94.7	98.9
1937	91.4	98.0	95.3	98.7	97.8	89.1	100.9	97.7	99.7	100.3
1938	93.8	98.5	98.6	104.6	102.2	92.4	103.7	101.7	104.7	106.7
1939	99.2	102.6	102.9	105.7	104.1	98.2	102.0	105.0	105.5	106.7

Annual Averages By Cities	Residences		Apartments, Hotels, Office Bldgs.			Commercial & Factory Bldgs.				
	Frame	Brick	Brick and Wood	Brick and Conc.	Steel	Frame	Steel	Brick and Wood	Brick and Steel	Brick and Conc.
NEW YORK CITY AREA										
1926–29	133.3	138.4	131.9	122.8	120.4	137.5	113.1	127.4	123.2	125.3
1913	59.5	60.6	57.5	53.9	54.8	61.4	51.4	53.[illegible]	53.2	53.7
1915	57.6	58.7	55.7	52.5	52.8	60.3	49.0	53.[illegible]	51.8	53.1
1916	65.9	67.5	65.1	62.3	65.2	67.8	75.6	62.3	69.0	62.1
1917	77.6	78.9	76.4	73.2	78.7	79.9	97.0	72.5	83.9	72.3
1918	87.7	89.9	86.4	82.2	87.2	89.2	98.2	83.[illegible]	89.2	83.1
1919	100.5	103.5	99.3	92.0	96.9	101.2	97.1	97.2	93.6	91.6
1920	136.9	142.0	135.8	123.3	130.0	137.1	120.9	135.0	122.6	123.6
1921	109.8	114.5	109.2	101.3	100.8	110.0	96.1	109.[illegible]	100.1	103.3
1922	109.5	114.3	109.0	99.0	98.7	109.8	88.0	109.[illegible]	96.3	100.1
1923	124.6	131.3	125.6	112.3	112.2	125.5	105.7	127.6	112.7	115.8
1924	123.5	129.1	123.6	114.4	113.9	125.0	108.5	122.4	115.6	115.7
1925	122.8	126.9	120.4	111.4	110.1	125.7	104.2	117.5	110.3	113.3
1926	131.4	136.9	130.1	120.3	116.7	133.7	118.3	128.1	118.2	123.0
1927	128.4	133.3	126.4	117.2	113.1	131.4	106.5	123.6	115.6	119.9
1928	136.5	140.2	133.5	125.8	122.6	140.5	112.4	126.6	128.2	128.0
1929	140.6	143.2	137.6	127.9	129.2	144.4	115.2	131.3	130.8	130.3
1930	126.7	132.6	125.3	124.1	118.7	131.9	113.8	120.3	123.6	128.0
1931	117.8	124.0	117.8	119.7	113.9	122.7	116.7	113.4	122.8	123.8
1932	100.4	108.1	102.6	105.5	99.8	104.8	102.2	99.8	109.1	112.0
1933	85.0	92.4	88.4	101.1	93.3	85.2	90.1	91.0	97.6	106.2
1934	98.3	104.5	100.2	108.2	103.5	99.8	104.6	100.2	108.8	112.2
1935	92.2	92.5	93.2	103.6	99.6	94.1	102.9	92.9	105.3	107.4
1936	96.4	101.8	97.4	106.8	102.2	98.8	104.9	96.2	107.2	110.5
1937	110.5	115.8	111.2	119.6	116.5	113.1	117.8	113.4	122.8	123.8
1938	118.9	121.4	119.6	128.4	124.0	121.9	123.2	117.0	128.3	130.4
1939	122.1	123.3	122.5	130.6	125.9	125.6	123.7	119.6	130.0	133.3
PITTSBURGH AREA										
1926–29	113.3	118.8	112.8	111.2	107.1	115.4	89.6	112.2	104.6	112.9
1935	84.1	90.5	86.1	94.9	83.9	82.2	72.3	89.5	80.9	86.6
1936	92.8	100.4	95.8	97.9	93.8	92.4	82.6	98.4	93.4	101.8
1937	109.8	117.5	112.9	112.1	109.0	109.1	102.1	115.3	110.6	114.1
1938	112.7	116.4	114.7	117.1	113.7	113.2	114.2	115.6	116.6	118.9
1939	113.8	117.0	115.7	117.5	114.2	114.2	109.8	116.5	116.9	119.1
ST. LOUIS AREA										
1926–29	118.6	121.1	115.7	109.9	108.8	121.3	103.3	111.2	107.7	109.3
1913	62.6	63.7	60.0	56.7	57.3	63.9	53.4	57.8	54.7	57.6
1915	62.1	63.7	60.3	56.9	56.3	63.6	52.6	57.9	55.1	58.6
1916	58.8	61.3	59.7	62.6	64.9	59.5	79.9	58.1	70.1	62.8
1917	69.7	71.4	69.5	71.7	79.5	71.1	95.3	66.5	81.3	71.5
1918	88.4	89.8	86.3	82.5	87.9	90.6	99.2	81.4	89.1	82.7
1919	95.0	97.5	93.6	91.4	96.4	96.7	99.1	90.1	93.8	91.6
1920	121.0	123.3	118.5	112.1	120.0	123.4	116.1	113.7	113.1	110.7
1921	113.3	116.5	110.5	105.0	104.1	115.3	99.4	107.4	103.2	106.7
1922	98.1	102.4	97.9	96.2	95.7	98.7	89.6	96.8	93.9	97.4
1923	116.5	120.9	115.4	110.2	110.2	119.0	104.9	112.6	109.4	111.7
1924	122.1	126.9	120.7	117.3	114.6	125.0	109.1	117.8	115.7	119.2
1925	118.4	123.6	117.9	116.3	113.2	120.9	107.0	115.6	114.4	118.7
1926	120.7	125.4	119.6	115.5	112.8	123.8	106.5	116.5	114.3	116.9
1927	118.1	122.7	116.7	113.5	110.1	121.2	105.4	113.5	112.5	116.0
1928	117.9	119.2	114.2	106.6	97.5	121.1	102.7	110.6	103.6	106.6
1929	117.7	118.1	112.3	104.0	97.2	119.0	98.6	106.2	100.4	103.8
1930	108.3	113.2	108.4	112.4	107.9	110.6	106.2	106.0	111.3	115.3
1931	103.3	108.4	104.0	108.0	102.9	105.6	102.8	102.1	107.8	110.5
1932	95.0	100.7	96.5	99.0	94.6	97.1	97.0	95.0	101.2	102.4
1933	87.3	94.0	90.1	97.9	93.2	88.4	96.8	90.2	99.6	102.8
1934	97.6	105.5	101.7	105.9	102.3	97.2	102.6	103.7	107.6	109.7
1935	91.6	99.7	96.4	104.2	99.3	90.7	101.8	98.9	105.7	108.6
1936	91.0	99.1	95.5	104.9	100.7	90.5	103.3	98.1	106.2	106.6
1937	98.2	106.5	103.2	113.1	111.1	97.8	114.8	106.0	117.0	117.6
1938	104.1	108.5	107.5	118.5	116.4	103.7	117.1	108.5	120.5	122.4
1939	107.0	110.2	109.9	118.7	116.4	107.6	114.3	110.3	119.2	119.8
SAN FRANCISCO AREA										
1926–29	87.7	93.7	90.4	97.5	96.5	86.1	95.5	91.8	95.9	99.0
1913	51.7	56.8	55.0	63.8	61.4	49.7	68.8	57.1	64.4	67.8
1915	51.1	56.3	53.9	62.5	58.5	49.0	60.7	56.2	59.8	67.5
1916	54.1	59.3	58.3	67.6	67.7	52.2	86.2	60.2	73.9	70.1
1917	63.0	67.7	67.8	77.2	81.9	61.7	118.7	68.0	94.6	78.1
1918	76.6	81.0	79.1	85.8	89.1	75.5	109.2	78.7	94.3	87.4
1919	87.8	92.7	90.1	96.7	100.1	87.2	112.1	89.7	102.2	98.5
1920	107.5	112.8	109.8	115.2	121.1	106.9	133.0	109.6	122.1	115.1
1921	89.5	96.8	93.8	102.3	100.2	86.3	106.5	97.2	103.8	105.6
1922	88.3	94.7	91.1	97.1	95.2	86.9	94.9	92.9	95.6	100.5
1923	98.7	104.8	100.8	103.1	103.0	98.8	103.5	100.8	103.1	106.4
1924	86.7	94.2	91.2	99.9	98.0	84.6	99.7	94.3	99.7	103.8
1925	86.5	93.9	91.1	99.5	97.9	84.1	97.0	93.4	98.0	102.1
1926	88.6	96.5	92.2	103.3	100.3	87.3	100.0	95.2	102.6	107.0
1927	87.2	94.8	91.2	102.1	98.3	86.1	97.2	93.1	100.5	103.3
1928	88.1	93.2	90.1	93.1	94.9	86.0	93.5	90.8	90.5	94.4
1929	86.9	90.3	88.1	91.9	92.5	85.0	91.3	88.1	90.0	92.3
1930	86.8	93.8	90.3	100.4	96.8	86.2	100.0	92.0	100.4	104.9
1931	80.6	88.8	85.6	94.6	90.6	79.2	92.5	87.3	94.8	100.7
1932	76.4	84.3	81.6	87.9	84.0	75.4	88.0	84.6	89.8	94.1
1933	68.4	76.7	74.3	84.7	81.0	66.3	82.1	78.5	85.3	89.5
1934	85.0	93.2	90.5	97.5	94.5	82.9	97.2	94.7	99.3	102.4
1935	84.1	91.6	89.0	96.5	94.9	82.1	99.9	92.9	99.8	103.7
1936	86.5	95.6	92.3	103.5	99.8	84.8	102.6	96.2	104.3	109.7
1937	96.7	104.3	101.9	112.2	109.8	95.4	113.0	104.8	113.3	116.0
1938	97.7	105.3	101.8	115.8	112.3	96.1	115.7	105.9	116.0	120.2
1939	99.2	105.7	104.5	117.4	114.4	97.6	114.9	107.4	116.5	121.9
SEATTLE AREA										
1926–29	84.5	92.2	89.2	101.7	95.1	82.4	100.8	92.2	100.5	105.9
1935	81.1	88.6	85.6	92.8	94.6	78.5	99.0	88.1	98.1	101.2
1936	79.8	86.5	83.6	93.7	92.2	77.3	97.4	85.7	95.2	96.5
1937	92.6	103.5	100.4	116.0	110.0	90.0	117.0	106.8	118.1	122.2
1938	96.5	104.3	103.5	119.8	115.7	94.0	120.2	107.6	120.8	125.6
1939	96.7	104.4	103.8	119.2	114.9	94.4	115.1	108.3	118.7	125.3

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See page 92, Apr. 27, 1939 issue for 1914 data of long series.

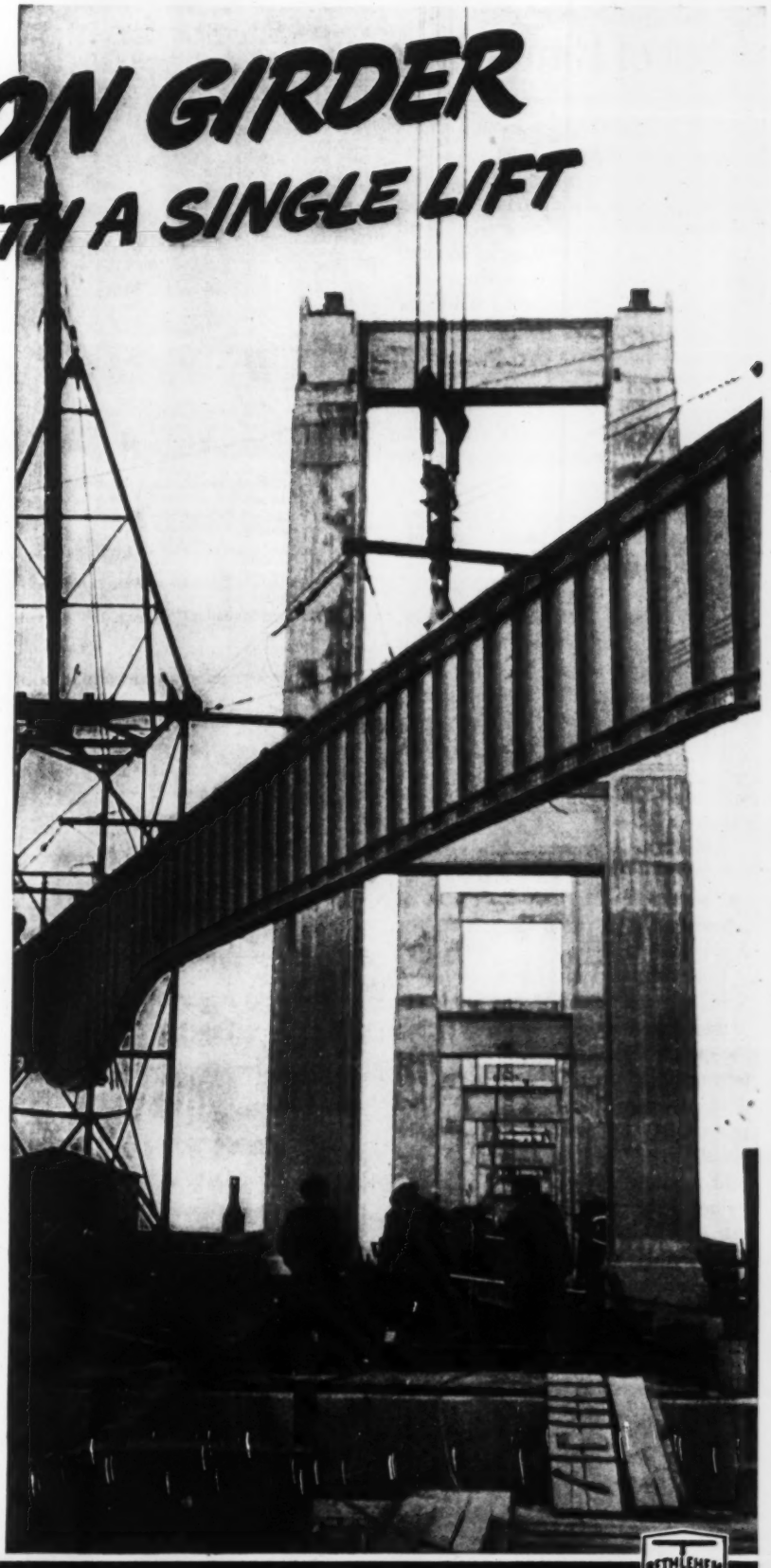
For definition of this index see p. 93

200 TON GIRDER PLACED WITH A SINGLE LIFT

The heaviest steel plate girders ever fabricated in this country form the center span of the new Thomas A. Edison memorial bridge over the Raritan River at South Amboy, New Jersey.

This 260-ft. member weighs approximately 200 tons, and is 21 ft. deep at the pier end and 13 ft. deep at the shallow end. It was lifted into position at a single pick. A floating rig and a giant traveller worked together to make the record breaking lift. The Thomas A. Edison bridge has 29 spans totalling 4386 ft.—one of the longest deck girder structures in North America.

Bethlehem handles difficult and unusual jobs like this with the efficiency that comes with knowing how. Forty years of outstanding work in the fabricating and erecting field have given Bethlehem engineers the wide experience necessary to handle any steel construction job smoothly and promptly.



Lifting the first of the 200 ton center span girders in the Thomas A. Edison bridge.

BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL

Cost of Financing

COST of construction money ended 1939 at a lower level than prevailed in the preceding year. In private fields, cost of industrial financing as measured by high-grade bond yields was 5.01 per cent in 1939, compared with 5.07 in the preceding year. Public utility yields were 4.48 per cent, compared with 4.80 in 1938; and railroad, 7.65, as against 8.37 per cent.

New record low costs were established for both federal, and state and municipal bonds. Federal yields for 1939 dropped to 2.36 per cent; state and municipal, to 2.76 per cent.

All of the above bond costs, except railroad, rose sharply at the outbreak of the European War in September. Their April, 1940 averages, however, are well below the September figures and the averages for 1939, again excepting railroads. Industrial yields are currently at 4.78 per cent; public utility, 4.32 per cent; railroad, 7.61 per cent; federal, 2.25 per cent; and state and municipal, 2.56 per cent.

Almost 40 per cent of the $1,127,000,000 volume of state and municipal bond sales for 1940 were sold at interest rates in the neighborhood of 2 per cent.

Commercial loan rates, or averages of rates charged by banks in principal cities, increased slightly for the quarter ending March, 1940. The current New York City rate, 2.03 per cent, tops the December figure, 1.96 per cent. The rate for seven other Northern and Eastern Cities, 2.67 per cent, compares with the year-end value of 2.59 per cent; eleven Southern and Western Cities' charge, 3.35 per cent, is just above the 3.32 per cent rate for the end of 1939. The current figures, however, are below those quoted for March, 1939.

BOND YIELDS — PER CENT

	U. S. Treas. (1)	Municipal (2)	Industrial (3)	Pub. Util. (4)	Railroad (5)
1932 Ave.	3.68	4.65	7.46	5.36	5.99
1933 Ave.	3.31	4.71	6.93	5.18	5.65
1934 Ave.	3.12	4.03	5.30	4.62	4.66
1935 Ave.	2.79	3.41	4.61	4.31	4.93
1936 Ave.	2.65	3.07	4.37	4.02	4.42
1937 Ave.	2.68	3.10	4.60	4.35	4.92
1938 Ave.	2.56	2.91	5.07	4.80	8.37
1939 Ave.	2.36	2.76	5.01	4.48	7.65
1939 Jan.	2.47	2.70	5.08	4.54	7.61
Feb.	2.44	2.70	4.98	4.52	7.66
Mar.	2.34	2.67	4.90	4.45	7.41
Apr.	2.30	2.75	5.08	4.55	7.79
May	2.17	2.66	5.00	4.47	7.73
June	2.13	2.63	4.91	4.47	7.63
July	2.16	2.65	4.90	4.42	7.70
Aug.	2.21	2.75	4.94	4.41	7.69
Sept.	2.65	3.29	5.21	4.61	7.65
Oct.	2.60	3.08	5.07	4.48	7.49
Nov.	2.46	2.89	4.99	4.39	7.57
Dec.	2.35	2.56	5.02	4.39	7.81
1940 Jan.	2.30	2.54	4.92	4.34	7.56
Feb.	2.32	2.60	4.93	4.33	7.57
Mar.	2.25	2.58	4.81	4.34	7.57
Apr.	2.25	2.56	4.78	4.32	7.61

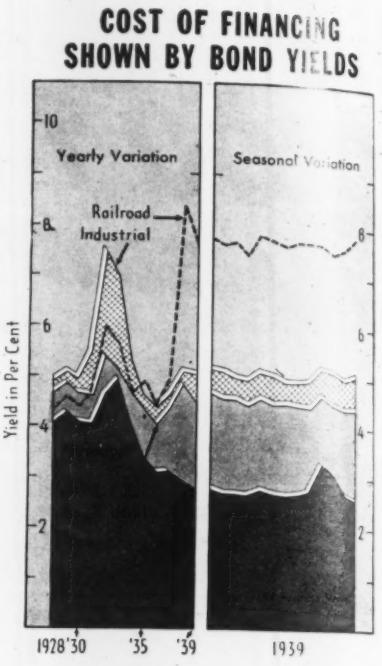
(1) Ave. all U. S. bonds except those due or callable within 12 years.

(2) Standard Statistics Co.— Ave. 15 high-grade long-term municipal issues.

(3) Standard Statistics Co.— Ave. 15 high-grade industrials.

(4) Standard Statistics Co.— Ave. 15 high-grade public utility issues.

(5) Standard Statistics Co.— Ave. 15 high-grade rail issues.

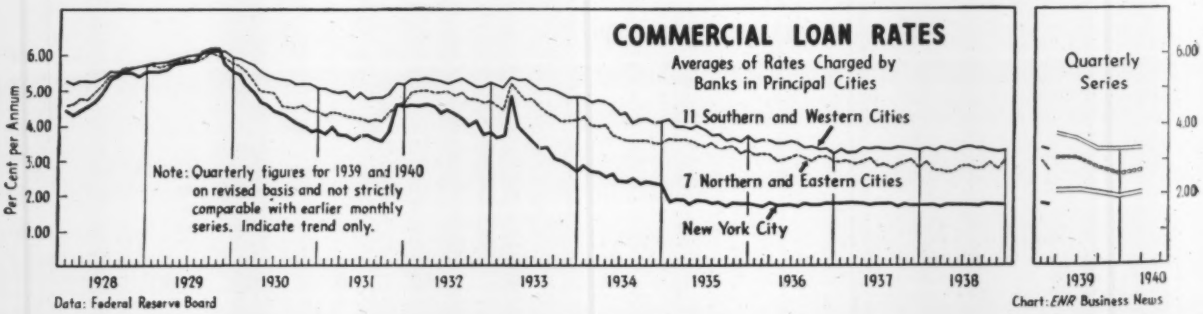


RATE OF INTEREST — MUNICIPAL BOND SALES IN THE U. S. FROM COMMERCIAL & FINANCIAL CHRONICLE

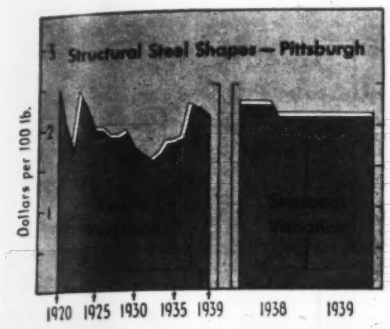
(Millions of Dollars — 000,000 Omitted)

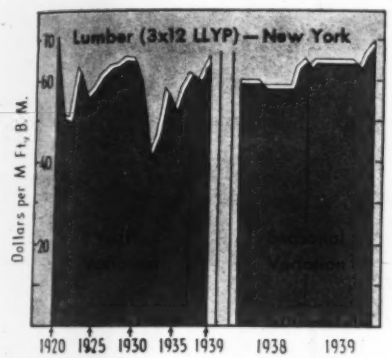
Year	2%	3%	3¼%	3½%	3¾%	4%	4¼%	4½%	4¾%	5%	Over 5¼%	5½%	5¾%	6% & over	Not Known
1901	...	11	...	**69**	...	28	...	5	...	9	3	...	...	...	7
1902	...	12	...	**77**	...	34	...	4	...	10	2	...	...	...	8
1903	...	17	...	**55**	...	47	...	9	...	14	5	...	...	...	5
1904	...	13	...	**123**	...	75	...	12	...	20	4	...	...	...	4
1905	...	6	...	**81**	...	55	...	14	...	19	6	...	...	...	3
1906	...	17	...	19	...	**120**	...	15	...	17	7	...	...	...	6
1907	...	9	...	8	...	**98**	...	69	...	26	8	...	...	...	9
1908	...	8	...	10	...	**124**	...	104	...	42	13	...	...	...	11
1909	...	21	...	17	...	**163**	...	49	...	55	25	...	...	...	10
1910	...	15	...	17	...	**95**	...	53	...	45	31	...	...	...	63
1911	...	2	...	7	...	**127**	...	89	...	65	29	...	...	...	78
1912	...	3	...	5	...	**101**	80	87	...	68	32	...	...	...	10
1913	...	19	...	4	...	80	20	**132**	...	108	31	...	...	...	10
1914	...	15	...	...	...	72	77	**153**	...	107	40	...	...	...	11
1915	...	2	...	...	...	85	46	**192**	...	117	44	...	...	...	12
1916	...	2	...	1	...	**125**	80	105	...	92	38	...	...	...	13
1917	...	9	...	1	...	96	16	**150**	...	120	42	...	...	...	18
1918	...	2	...	...	...	19	4	69	...	**98**	74	...	...	...	30
1919	...	4	...	...	...	19	22	132	28	**278**	150	...	...	...	59
1920	...	...	...	15	...	24	3	71	9	194	**333**	...	...	...	34
1921	...	...	...	...	...	53	3	125	36	330	**656**	...	...	...	26
1922	...	1	...	...	...	105	131	219	56	**307**	252	...	...	...	32
1923	...	...	...	...	...	98	102	**272**	138	237	203	...	...	...	13
1924	...	...	4	...	...	150	**339**	291	109	281	203	...	...	...	22
1925	...	...	1	...	...	270	**302**	318	76	202	201	...	...	...	30
1926	...	...	...	...	...	212	287	**342**	76	215	199	...	...	...	35
1927	...	16	10	...	...	**361**	321	336	79	180	160	...	...	...	46
1928	...	...	37	...	...	**365**	384	281	68	150	111	...	...	...	19
1929	...	3	65	...	...	107	133	**449**	132	250	281	...	...	...	10
1930	...	2	60	...	...	338	326	**341**	150	155	97	...	...	...	18
1931	...	92	...	181	...	**241**	311	197	51	99	77	...	...	...	6
1932	...	31	...	19	...	68	56	151	73	122	**322**	...	...	...	7
1933	...	32	15	29	39	**131**	48	51	22	61	3	20	3	52	15
1934	84	107	94	54	72	**197**	54	75	41	88	13	23	4	13	20
1935	161	**349**	62	137	71	234	40	50	22	26	3	3	2	9	50
1936	211	**343**	71	156	35	212	14	23	3	16	1	1	...	2	28
1937	73	**422**	55	95	50	134	26	13	3	7	1	1	...	1	21
1938	**360**	256	105	102	54	149	21	11	8	8	3	...	1	1	20
1939	**446**	282	80	58	30	128	71	8	2	4	...	1	...	1	15

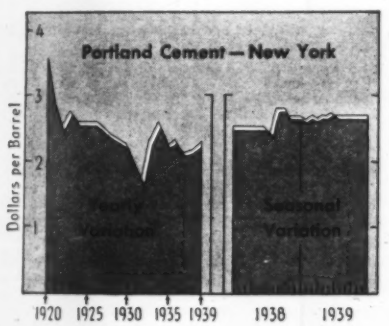
Bold face type indicates interest rates on which bulk of financing was done for year.

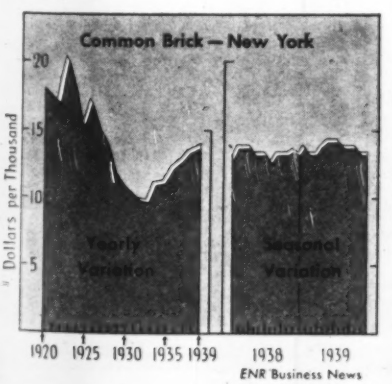


CONSTRUCTION MATERIAL PRICES
1920–1939
(ENR 20-Cities' Aver.)









ENR Business News

Prices of Construction Materials

CONSTRUCTION material price averages for 1939 in New York were generally higher, with lumber recording an 8 per cent gain over 1938; common brick up 2.7 per cent; and cement 3.8 per cent higher. The Pittsburgh base price average for structural steel shapes, however, dropped 3.7 per cent below the 1938 average.

Long leaf yellow pine lumber in New York ranged between $63.00 in January, 1939, and $68.50 in December. Common brick opened the year at $13.50 and closed at $13.00.

Basic Building Materials Prices

1874 to 1939 in New York City

Average yearly prices at New York, except in the case of steel, which is f. o. b. Pittsburgh mill; wrought, iron I beams for years, 1879, 1885 and 1886. Brick, wholesale, f. o. b. Lime, common lump, wholesale, f. o. b., 180 lb., net., 1910–15, incl.; afterward, 280 lb. Cement, net, delivered; *Rosendale, 1874 to 1878, incl.*; afterward, Portland. Lumber, No. 1 com., rough, wholesale, at dock, for 1 in., yel. pine, 1874 to 1909, incl.; afterward, 3 in., long-leaf to 1913, incl. *LLYP–3 x 12 — from Lumber Trade Journal. †LLYP–12 x 12 as reported to Engineering News-Record. Cast iron pipe price per ton f. o. b. Delaware River foundries; *prices prior to 1901 are for all classes of bell and spigot;* prices subsequent to 1901 are for 6-in. and larger Cl. B or heavier bell and spigot; early prices from "Price History of Cast Iron Pipe" by United States Cast Iron Pipe and Foundry Co.; prices 1850, $35.72; 1855, $40.18; 1860, $32.15; 1865, $58.05; 1870, $50.

	Brick Common Per M	Cement Per Bbl.	Lime Per Bbl.	Pine per M. Ft. B.m.		Steel Shapes, Per 100 Lb.	Cast Iron Pipe, Per Ton
1874	$7.41	*$1.48*	$1.50	$26.00		....	*$43.76*
1875	7.12	*1.25*	1.40	21.00		....	*37.51*
1876	5.87	*1.20*	1.00	21.00		....	*31.26*
1877	4.93	*1.10*	.80	20.00		....	*25.00*
1878	4.71	.95	.70	20.00		....	*23.22*
1879	4.08	2.70	.80	20.96		$2.78	*29.47*
1880	7.00	2.88	.87	19.00		....	*29.47*
1881	7.50	2.72	.95	19.00		....	*33.04*
1882	7.12	2.82	1.01	19.00		....	*35.68*
1883	8.28	2.75	1.05	19.00		....	*32.15*
1884	6.65	2.60	.95	19.00		....	*26.79*
1885	6.10	2.28	1.00	18.66		3.12	*25.00*
1886	7.51	2.28	1.00	19.00		3.00	*26.79*
1887	7.43	2.07	.82	19.00		....	*28.58*
1888	6.50	2.16	.83	16.75		....	*25.00*
1889	7.06	2.23	.92	20.31		....	*23.04*
1890	6.65	2.25	.95	21.75		....	*24.65*
1891	5.53	2.38	.87	18.00		....	*23.04*
1892	5.77	2.27	.93	18.50		....	*21.43*
1893	5.83	2.15	.93	18.50		....	*21.30*
1894	5.00	2.03	.85	18.50		1.20	*18.47*
1895	5.31	1.97	.78	16.92		1.35	*17.95*
1896	5.06	2.00	.69	16.42		1.60	*17.64*
1897	4.94	1.97	.72	16.44		1.24	*15.48*
1898	5.75	2.00	.70	15.75		1.27½	*15.48*
1899	5.69	2.05	.75	16.25		1.45	*21.17*
1900	5.25	2.16	.68	24.50		1.95	*22.33*
1901	5.77	1.89	.77	17.50		1.60	*21.63*
1902	5.39	1.95	.81	21.00		1.60	26.62
1903	5.91	2.03	.79	23.50		1.70	27.56
1904	7.50	1.67½	.80	21.50		1.60	22.92
1905	8.10	1.43	.89	24.92		1.62	26.54
1906	8.55	1.55	.95	29.33		1.60	30.12
1907	6.16	1.55	.95	30.50		1.75	31.52
1908	5.10	1.46	1.05	30.50		1.76	24.69
1909	6.39	1.41	1.05	33.04		1.50	24.19
1910	5.70	1.07	.75	24.00		1.46	22.99
1911	5.31	1.04	.75	24.63		1.36	19.99
1912	6.75	.97	.75	24.92		1.33	21.22
1913	6.75	1.18	.91½	* 25.04	†	1.50	21.96
1914	5.50	1.17½	.97	21.79	29.25	1.16	20.37
1915	5.50	1.00	.97	21.68	27.91	1.28	22.52
1916	8.00	1.32	1.50	27.60	31.58	2.45	30.25
1917	9.10	1.76	2.02	38.00	37.81	3.62	52.33
1918	10.98	2.48	2.16	46.68	43.33	3.00	58.68
1919	15.79	2.63	2.65	57.04	49.60	2.52	53.87
1920	18.00	3.52	3.15	71.17	66.50	2.45	71.77
1921	17.40	2.82	3.47	50.67	51.54	2.00	50.58
1922	16.91	2.43	2.79	49.41	51.83	1.70	46.42
1923	20.00	2.66	2.98	61.77	62.25	2.39	57.75
1924	18.00	2.50	2.88	55.17	59.00	2.19	54.33
1925	15.00	2.50	2.38	57.00	59.67	1.95	49.16
1926	17.00	2.50	2.18	60.33	62.17	1.93	48.50
1927	15.00	2.40	2.49	62.57	61.46	1.86	41.42
1928	14.00	2.30	2.30	63.33	61.34	1.87	35.92
1929	11.71	2.23	2.25	64.50	63.00	1.92	36.66
1930	10.88	2.19	2.25	64.33	60.64	1.71	37.00
1931	10.29	1.89	2.25	58.17	53.02	1.63	34.71
1932	9.75	1.62	2.25	39.91	41.33	1.56	30.58
1933	9.50	2.26	2.50	46.25	46.79	1.64	34.58
1934	10.87	2.48	2.50	57.17	58.92	1.78	41.00
1935	11.00	2.15	2.35	51.67	53.75	1.80	42.58
1936	12.00	2.26	2.80	56.75	57.75	1.84	43.00
1937	12.50	2.07	2.80	61.50	66.46	2.21	48.75
1938	13.10	2.12	2.80	59.33	62.75	2.18	48.33
1939	13.46	2.20	2.80	64.35	62.50	2.10	46.75

INDEX NUMBERS OF WHOLESALE PRICES — BUREAU OF LABOR STATISTICS

(1926 = 100)	1939	1938	1937	1936	1935	1934	1933	1932	1931	1930
Building materials	90.5	90.3	95.2	86.7	85.3	86.2	77.0	71.4	79.2	89.9
Brick and tile	91.4	91.0	93.5	88.7	89.4	90.2	79.2	77.3	83.6	89.8
Cement	91.3	90.3	89.0	92.2	92.7	93.1	88.1	74.3	74.8	89.8
Lumber	93.4	90.4	99.0	84.5	81.1	84.5	70.7	58.5	69.5	85.8
Paint and paint materials	82.8	81.3	83.4	80.1	79.8	79.5	73.3	71.1	79.4	90.5
Plumbing and heating	79.2	78.5	78.8	75.0	68.9	72.6	67.1	66.8	84.7	88.6
Structural steel	107.3	111.0	113.2	95.0	92.0	90.8	83.1	80.9	83.1	87.3
Other building materials	90.3	92.7	99.1	90.2	90.1	90.3	82.7	79.5	84.8	93.3

MATERIALS AND LABOR PRICES

DECEMBER, 1939

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

DECEMBER construction material prices show only minor changes from those reported a month ago. Short Leaf Yellow Pine is off $1.00 per M ft. on most sizes in Atlanta; off $1.00 to $2.00 in St. Louis; but up $1.00 on the 2 x 6-in. size in Chicago; up 50c. on 2 x 6-in. and 2 x 8-in. sizes in Dallas; and up 50c. to $1.00 on all sizes in Baltimore. Douglas Fir is up 50c. to $1.00 in Baltimore; but $1.00 lower in Seattle; and $1.00 lower on the 2 x 6-in. in Chicago.

Seattle base price on Douglas Fir plywood is up $3.00 on the 5/8 in. size and $3.30 on the 3/4-in. size. Many manufacturers are still out of the market, however, and will not take orders.

Paving asphalt is up $1.00 per ton in Baltimore and New York, and $1.25 higher in Dallas. Ready-mixed concrete is up 25c. per cu. yd. in Minneapolis. Structural steel shapes have increased 60c. per 100 lb. in Dallas; Dallas price on new billet reinforcing bars is up 25c. per 100 lb. Welded fabric reinforcing is up on all sizes in all 20 cities.

Labor rates, both common and skilled, are unchanged from November levels. Cement, sand and gravel, crushed stone, brick, structural clay building tile, lime, cast iron pipe, verified sewer pipe and concrete sewer pipe also remains at their levels of a month ago.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT			SAND AND GRAVEL			CRUSHED STONE		CRUSHED SLAG		CONCRETE
	Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			Per ton, carload lots			Per ton, carload lots		Per ton, carload lots, f.o.b. plant		Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags*a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	$2.60	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	6.50
Birmingham	2.50	2.25	2.05	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.75*b*	2.50*b*	2.30	1.10‡	1.10‡	.80‡	1.10‡	1.10‡	....	....	6.75*m*
Chicago	2.75	2.50	2.35	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.29	2.04	....	1.45*i*	1.45*i*	1.45*i*	1.60*i*	1.60*i*	1.70*i*	1.70*i*	6.85*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.15	1.90	1.70	1.30	1.40	.81	1.45	1.45	1.14‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90*n*
Los Angeles	2.82*b*	2.62*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	3.00	2.75	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.60*j*
Montreal	....	....	1.48	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	7.60*k*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.40*de*	1.40*de*	.90*de*	1.65*de*	1.75*de*	....	....	7.25
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*h*
Pittsburgh	2.44	2.19	1.99	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.72	2.52	2.20	1.36	1.36	1.36	1.46	1.46	....	....	7.63
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.50*o*

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn.	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hannibal, Mo.	1.70	1.65	Norfolk, Va.	1.65	1.60	Universal, Pa.	1.65	1.60
Hudson, N. Y.	1.75	1.70	Northampton, Pa.	1.55	1.50	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70
Independence, Kans.	1.70	1.65	North Birmingham, Ala	1.70	1.65			

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS	ASPHALT EMULSION (Quick-breaking)	
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Per ton, less than 80 penetration		Per gal. 80-300 penetration		Per ton		Per gal.	Per gal.	
				Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$75.00	$39.35	$2.25	$16.60*e*	$21.80*e*	$0.0645*e*	$0.0945*e*	$0.0684*he*	$0.0984*h*	$0.0584*e*	$0.0644	$0.0684
Baltimore	145.00‡	44.00‡	2.50	13.00	18.00	.05	.08	.055*h*	.095*h*	.....	.....	.....
Birmingham	.....	28.50‡	.....	18.20	23.20	.0747	.1047	.0834*h*	.1484*h*	.....	.....	.....
Boston	80.00	47.00	3.25	13.00	18.00	.05	.08	.055*h*	.125*h*	.....	.09‡	.12‡
Chicago	150.00	52.00	1.80*d*	14.00	18.00	13.00*g*	17.00*g*	.0525*h*	.10*h*	.0275	.08	.12
Cincinnati	112.00	37.50	.....	14.31	18.31	.10	.....	18.00	.....	.0525	.....	.08
Cleveland	110.00	37.25	2.80	15.25	20.50	.07	.08	.07*h*	.085*h*	.035	.08	.09
Dallas	.....	30.00	.....	13.25	20.30	.06	.103	15.00	24.80	.053	.05/.07	.07/.09
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	13.60*f*	18.00*f*	.0593	.0994	13.60	18.00	.0535	.0545	.0924
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	6.50*b*	15.00	6.50*bg*	15.00*bg*	5.50*b*	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	.....	.....
Montreal	75.00	.....	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.07	.13	.16
New Orleans	.....	.....	.....	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	.....	.078	.....
New York	.....	68.00	2.75	13.50	18.50	.055	.08	.055*h*	.125*h*	.....	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	115.00	40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	.....	14.00	19.00	14.00*g*	19.00*g*	.06*h*	.095*h*	.04	.09	.125
San Francisco	.....	70.00	.....	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0475	.117
Seattle	.....	60.00*c*	.....	13.69	23.49	.....	24.09*g*	10.09/11.09	23.59/24.59	8.34*g*	.0575*i*	.1308

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in.

FOR TODAY'S AND TOMORROW'S CONCRETE NEEDS

POZZOLITH

brings Speed with Economy,
Durability, and
Important Savings.

To millions of yards of concrete placed in the last decade Pozzolith has added three factors, particularly essential at this time to our Country's defense facilities:—

SPEED . . .

Pozzolith gives high early strength for stripping, finishing and use.

DURABILITY . . .

Pozzolith increases Durability 50% . . . Strength 20% . . . Impermeability, by reducing water required for ideal placing 15 to 20%.

SAVINGS . . .

Through easier placing, earlier finishing, lower maintenance. Placeability increased 150% at equal water cement ratio.

POZZOLITH WILL HELP YOU DO YOUR JOB quicker and better. Important savings in time and money can be yours with this Master Builders' Product.

The Master Builders organization, backed by thirty years of specialization in the concrete field, is unusually fitted to serve you at this time when experience is invaluable.

Write for "Estimating Tables of Quantities" and other information that will be helpful to you on present and future construction.

Many of the leading corporations, engineers and contractors in the last decade have adopted Pozzolith Concrete in construction because of these factors. Here are a few of the regular users:—

COMPANIES

Westinghouse Electric and Mfg. Co.
Union Pacific R. R.
Erie R. R.
General Mills
Wheeling Steel Co.

ENGINEERS

Geo. Sowers, Cleveland, Ohio
J. E. Sirrine & Co., Greenville, S. C.
Black & Veach Engineering Co., Kansas City, Mo.
Consoer Townsend & Quinlan, Chicago, Ill.
Burgess & Niple, Columbus, Ohio
Thos. W. Bowe, New York, N. Y.
Morris Knowles, Inc., Pittsburgh, Pa.

THE MASTER BUILDERS COMPANY

Cleveland, Ohio — Toronto, Canada

TRADE MARK

POZZOLITH MAKES BETTER CONCRETE

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet *b*	RIVETS ½-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std. Spikes *c*	Tie Plates	Track Bolts
Birmingham	$2.10	$2.15	$3.40	$2.55	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.[illegible]	$4.15
Chicago	2.10	2.15	3.40	2.55	$2.40	40.00	40.00	39.00*e*	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.15	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.15	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	2.15	3.40	2.55	....	....	....	....	....	....	....	....
Youngstown	....	2.15	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.25‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45*a*	2.50*a*	....	....	2.85*a*	....	....	....	....	....	....	....
Pacific ports	2.70*a*	2.60*a*	....	....	2.90*a*	....	....	....	....	3.00	2.25	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone. Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l. *e* Re-rolled price withdrawn; market unsettled with scrap advance.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS* Per 100 lb., ¼ in., base price 15 tons or over *b* New billet	Rail steel	Add $/cwt. for Switch Del.	EXPANDED METAL LATH—Per 100 sq.yd., carload lots— Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING—Per 100 s.f., carload lots— 4x16 in., No. .5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.39	.02½	.10	$21.00	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore	3.60	2.85	2.70	.....	.10	20.50	22.50	1.70	1.27	.1611	2.70
Birmingham	2.10*a*	2.15	2.15	.02½	.10	19.50	21.50	1.80	1.34	.1701	....
Boston	4.00	2.73	2.58	$20 C.L.	.10	21.50	23.50	1.76	1.31	.1656	3.14
Chicago	2.10*a*	2.15	2.15	.03	.05	18.50	20.50	1.67	1.25	.1575	2.40
Cincinnati	3.68	2.51*c*	2.51*c*	.....	.05	20.50	22.50	1.66	1.25	.1566	....
Cleveland	3.58*g*	2.15	2.15	.02½	.10	21.00	23.00	1.66	1.25	.1566	....
Dallas	4.75	3.25	3.25	.....	.....	25.00	27.00	1.93	1.42	.1827	....
Denver	4.35	3.95	3.80	.....	.....	23.50	25.50	1.97	1.45	.1863	....
Detroit	3.80‡	2.60	2.45	.....	.10	22.50	24.50	1.68	1.26	.1584	2.81
Kansas City	4.03	2.51*c*	2.36*c*	.0	.05	18.50	20.50	1.78	1.33	.1683	2.86
Los Angeles	3.65*f*	2.65	2.50	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis	3.80‡	2.48*c*	2.48*c*	.0	.10	21.50	24.50	1.80	1.34	.1701	2.734
Montreal	3.80	2.65	2.55	.....	.....	26.00	28.50	2.99	2.08	.319	3.95
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.873
New York	3.75	2.39	2.39	.....	.10	20.50	22.50	1.72	1.29	.1629	2.74
Philadelphia	3.55	2.66	2.56	.....	.....	19.50	21.50	1.71	1.28	.1611	2.72
Pittsburgh	2.10*a*	2.15	2.15	.02½	.10	21.50	24.50	1.59	1.20	.1503	2.40
St. Louis	3.47	2.39	2.39	.0	.05	20.50	24.00	1.69	1.27	.1602	2.70
San Francisco	4.00	2.525	2.375	.02½	.10	23.50	25.50	1.93	1.42	.1827	3.25
Seattle	2.70*e*	2.40*c*	.....	.....	.....	25.50	27.50	1.93	1.42	.1827	2.90*e*

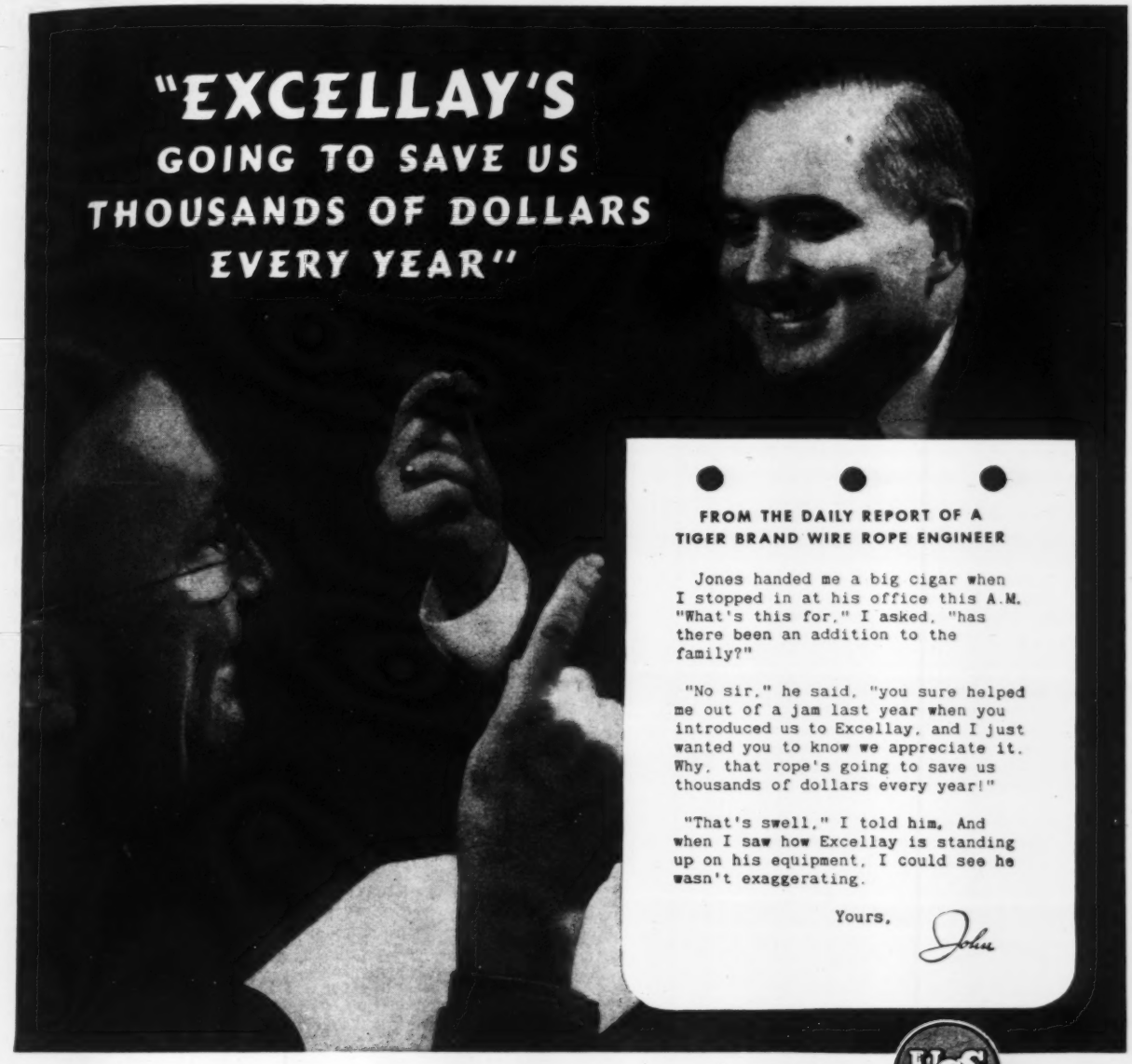
‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.*a*	VITRIFIED SEWER PIPE Per foot, 8 in., s.s.	delivered 12 in., s.s.	ASTM 24 in., d.s.	C13–35 36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Black %	Butt Weld 3½ to 6 in., Lap Weld Galv. %	Black %	Galv. %
Atlanta	$49.40	$0.26*bc*	$0.468*bc*	$1.8525	$4.68*c*	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	52.80	.30	.55	2.30	6.80	110.00	150.00	.40	1.60	65.5	57.5	63.0	54.5
Birmingham	45.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	55.00	.294	.567	2.16	6.15	199.00‡	288.00‡	.50	2.50	64.1	56.1	61.6	53.1
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	52.70	.259	.4995	1.935	5.6375	75.00	120.00	.60	1.90	65.9	57.9	63.4	54.9
Cleveland	54.24	.224	.432	1.665	5.0225	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	58.20	.265	.477	1.728	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	60.60	.24†	.52†	2.16†	.....	130.00	240.00	.....	.....	58.4	50.4	55.7	47.2
Detroit	54.24	.147	.2835	1.215	4.70	66.45	111.40	.162	1.125	66.3	58.3	63.8	55.3
Kansas City	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8
Minneapolis	57.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.55	.90	3.15	5.10*e*	135.00‡	260.00‡	.48	1.92	.....	.....	.....	.....
New Orleans	51.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	52.20	.32	.63	2.52	6.45	.....	.....	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	50.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis	52.48	.26	.504	2.016	3.96	85.00	170.00	.75*j*	1.80*k*	65.1	57.1	62.0	53.5
San Francisco	55.00	.3275*d*	.5895*d*	2.358	5.895	107.25	178.75	.45	2.50	.....	.....	.....	.....
Seattle	55.35	.35	.63	2.52	6.30	72.00	175.00	.45*f*	1.40*f*	.....	.....	.....	.....

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ½ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld — 1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld — 2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

"EXCELLAY'S GOING TO SAVE US THOUSANDS OF DOLLARS EVERY YEAR"



FROM THE DAILY REPORT OF A TIGER BRAND WIRE ROPE ENGINEER

Jones handed me a big cigar when I stopped in at his office this A.M. "What's this for," I asked, "has there been an addition to the family?"

"No sir," he said, "you sure helped me out of a jam last year when you introduced us to Excellay, and I just wanted you to know we appreciate it. Why, that rope's going to save us thousands of dollars every year!"

"That's swell," I told him. And when I saw how Excellay is standing up on his equipment, I could see he wasn't exaggerating.

Yours, John

WHEREVER wire rope is used, you can be sure that not far away is one of the arms of the American Steel & Wire Company, the Tiger Brand Wire Rope Engineer.

What these men accomplish is no mystery to the thousands of wire rope users they contact every year. They know your problems, they talk your language. Their job is to help you select the best wire rope for a given task—to help you put wire rope to the most effective use—in short, to help you get a full dollar's worth of performance out of every dollar you invest in wire rope.

Get to know your American Tiger Brand Engineer better. He's in position to give you practical, down-to-earth, money-saving assistance. If for any reason you are not being contacted by one of these engineers, write or call us and you'll learn the true meaning of real wire rope service.

USS

EXCELLAY *Preformed* **WIRE ROPE**

AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York

COLUMBIA STEEL COMPANY
San Francisco

United States Steel Export Company, New York

UNITED STATES STEEL

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) *All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD* Rail freight increment (See note for base price)	
	1x6, [a][g]	1x8, [a][g]	2x4, [a][g]	2x6, [a][g]	2x8, [a][g]	2x10, [a][g]	3x12, [g][h]	6x12, [g][h]	12x12, [g][h]	2x12, [g][h]	12x12, [g][h]	⅜"	¾"
Atlanta	$19.00	$19.00	$18.00	$20.00	$19.50	$21.00	$26.00	.....	.....	$38.50	$50.50	$17.75	$21.60
Baltimore	29.00	30.50	35.50	34.50	35.00	36.00	43.50	.....	.....	66.00	67.00	17.35*g*	21.15*g*
	31.00	*31.00*	*33.00*	*32.00*	*33.00*	*33.00*	*43.50*	*$43.50*	*$39.00*	.....	.....	.....	.....
Birmingham	22.50	23.50	22.00	21.00	22.00	23.00	37.00	36.00	36.00	.....	.....	16.25	19.85
[j]	25.50	25.50	29.00	27.00	29.00	40.00	60.00	.....	.....	52.00	60.00	.....	.....
Boston	32.00[j]	32.00[j]	34.00[j]	34.00	53.00[j]	63.00[j]	77.00[j]	.....	.....	77.00	77.00	17.35*g*	21.15*g*
	29.00	*29.00*	*34.00*	*34.00*	*36.00*	*36.00*	*45.00*	*45.00*	*50.00*	.....	.....	.....	.....
Chicago	33.00	34.00	34.00	34.00	34.00	35.00	50.00	.....	.....	80.00	90.00	13.15	16.05
	37.00	*37.00*	*40.00*	*38.00*	*40.00*	*41.00*	*44.00*	*43.00*	*43.00*	.....	.....	.....	.....
Cincinnati	31.50	33.00	30.50	31.00	32.00	35.00	44.50	.....	.....	53.00	56.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	*46.00*	*46.00*	*46.00*	.....	.....	.....	.....
Cleveland	33.00	33.50	33.00	33.50	35.00	37.00	44.00	46.00	46.00	80.00	80.00	16.65	20.25
Dallas *e*	28.50	32.00	31.50	29.00	30.50	32.50	52.50	52.50	52.50	63.50	71.00	13.90	16.95
Denver ‡	44.00[i]	42.00[i]	40.00[i]	43.00[i]	48.00[i]	43.00[i]	48.00[i]	60.00[i]	71.50[i]	.....	.....	9.90	12.05
Detroit	35.00	35.00	35.00	35.00	38.50	42.00	46.00	.....	.....	43.50	58.00	16.25	19.85
	.....	.....	.....	.....	.....	*48.00*	*47.00*	*54.00*	*54.00*	.....	.....	.....	.....
Kansas City	29.00	31.00	30.00	28.50	29.00	31.00	35.00	.....	.....	55.00	60.00	12.25	14.95
	29.00	*30.00*	*30.00*	*28.50*	*29.00*	*30.00*	*35.00*	*59.00*	*59.00*	.....	.....	.....	.....
Los Angeles *a*	*36.00*	*35.00*	*36.00*	*33.00*	*33.00*	*33.00*	*38.00*	*46.00*	*39.00*	.....	.....	9.35*gh*	11.35*gh*
Minneapolis *b*	47.00[k]	47.00[k]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
‡	*38.00*	*38.00*	*39.00*	*39.00*	*39.00*	*39.00*	*59.00*	*59.00*	*59.00*	.....	.....	.....	.....
Montreal [l]	*44.00*	*44.00*	*49.00*	*47.00*	48.00	58.00	84.00	.....	.....	155.00	165.00	.....	.....
	40.00	*40.00*	*40.00*	*40.00*	*40.00*	*41.50*	*41.00*	*40.00*	*39.00*	.....	.....	.....	.....
New Orleans	24.00	25.00	25.00	24.00	24.00	25.00	46.00	.....	.....	62.00	69.00	13.90	16.95
	29.00	*29.00*	*32.00*	*33.00*	*35.00*	*34.00*	*36.00*	.....	.....	.....	.....	.....	.....
New York ‡	38.00	39.00	37.00	38.00	38.00	39.00	42.00	.....	.....	80.00*f*	82.50*f*	17.35*g*	21.15*g*
‡	.....	.....	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*47.50*	*47.50*	.....	.....	.....	.....
Philadelphia	24.00	24.50	25.50	25.50	27.50	27.50	29.00	.....	.....	55.00	57.50	17.35*g*	21.15*g*
	55.00	*56.50*	*39.00*	*38.25*	*39.00*	*39.00*	*44.00*	*32.00*	*32.00*	.....	.....	.....	.....
Pittsburgh	38.10	39.90	47.05	42.00	45.65	46.90	59.70	.....	.....	.....	.....	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis ‡	33.00	34.00	32.00	31.00	32.00	33.00	48.00	53.00	53.00	73.00	72.00	13.90	16.95
San Francisco *d*	*22.50*	*22.00*	*22.50*	*22.50*	*21.50*	*21.50*	*23.50*	*23.50*	*23.50*	.....	.....	7.30*g*	8.90*g*
Seattle	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*26.00*	*26.00*	*26.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Pine. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft. *k* These are October prices; unable to obtain November or December quotations.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on ⅜", $77.00; on ¾", $84.80; price includes oiling and sealing charges. For other centers add rail freight increment from table for proper size. For resin dipped treatment, add $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

* Plywood prices to hold for balance of year, but many manufacturers are out of market. Will not take future orders.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Sept. 15, 1928 Single or Double Thickness A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*	
Atlanta	75%*d*	75%*d*	$0.15	
Baltimore	83%*d*	82%*d*	.15	
Birmingham	89%	90%	.105	
Boston	82%*d*	82%*d*	.15	
Chicago	79%*d*	79%*d*	.15	
Cincinnati	79%*d*	79%*d*	.15	
Cleveland	88-10-10%	88-10-10%	.19	
Dallas	78%*d*	78%*d*	.165	
Denver	76-10%*d*	76-10%*d*	.15*e*	
Detroit	79-10%*d*	79-10%*d*	.15	
Kansas City	79-10%*d*	79-10%*d*	.155	
Los Angeles	86%	88%	.1575	
Minneapolis	76%*d*	76%*d*	.155	
Montreal	70-10%*ab*		.17†	
New Orleans	80%*d*	80%*d*	.16	
New York	82%*d*	83%*d*	.20*f*	
Philadelphia	82-10%	83-10%	.15	
Pittsburgh	79%*d*	79%*d*	.1425	
St. Louis	79-10%*d*	79-10%*d*	.155	
San Francisco	78%	83%	.155	
Seattle	85%	88%	.1575	

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Aug. 15, 1938.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.105	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla	.11 -.12	.135 -.15	.155 -.17
Rocky Mtn. States	.11 -.1325	.13 -.145**	.15 -.165**
Pacific N. W. States	.1075-.115	.1375-.15	.1575-.17
Pacific S. W. States	.1050-.1175	.135 -.1475	.155 -.1625

** F.o.b. Louviers, Colo., or Butte, Mont

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6" x 8" x 8' Untr.	6" x 8" x 8' Tr.	7" x 9" x 8'6" Untr.	7" x 9" x 8'6" Tr.
Boston	Oak	$1.20	....	$1.65	....
	Pine	1.50	$2.25*a*	2.25	$3.20*a*
New York	S. L. Sap Pine	1.10/1.20	1.85	1.50	2.35
	Mixed Oak	1.45	1.95	1.90	2.45
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.25*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.04	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.12	....	1.50	....
	Red Oak	1.12	1.60*a*	1.50	2.03*a*
	Sap Pine or Cypress	1.02	....	1.40	....
San Francisco	Douglas Fir	.90*bef*	....	....	1.95*caf*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

Tr.—Treated; Untr.—Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00-2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	22.00-35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb	4.75

GELEX

REG. U. S. PAT. OFF.

A 10-Year Record in Popularity:

1930– 1,500,000 pounds

1939–28,440,000 pounds

THESE figures speak for themselves . . . how GELEX has grown in popularity ever since its introduction.

And here's the reason:

GELEX is efficient and economical. It detonates with high velocity. Its strong, shattering action gives excellent fragmentation...which means low cost per ton of material moved. It has a minimum of noxious fumes. It is plastic and cohesive...easy to load. Its water resistance is so good that GELEX may often be substituted for gelatins at a saving.

Because it gives such outstanding performance at low cost, more and more contractors are switching to GELEX every year!

E. I. du Pont de Nemours & Co. (Inc.)
Explosives Dept., Wilmington, Delaware

NOTE: Visit the DU PONT Wonder World of Chemistry Exhibit at the New York World's Fair.

DU PONT EXPLOSIVES *and* BLASTING ACCESSORIES

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	BRICK Per M. in quantity. Common backing	Straight hard	LIME Per ton, Hydrated finishing	In paper Common hydrated	Carload lots Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$24.00	$15.50	$15.50
Baltimore	74.00	80.00	165.00	190.00	240.00	290.00	13.00*k*	16.00*k*	18.50	14.50	2.50*m*
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	25.00	17.50	2.00*o*
Boston	82.10*a*	87.60*a*	164.20*a*	186.10*a*	243.20*a*	277.90*a*	17.00*i*	20.00*i*	19.00	12.50	3.10*p*
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	54.50	58.00	109.00	130.50	175.50	200.50	16.00	16.00	16.00*j*	14.00*j*	2.75*m*
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	84.80	95.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00*j*	17.00*j*	35.00*q*
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	15.70	17.00	13.50	11.75	12.75
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.00	15.00	16.50	.....	17.50
Minneapolis	66.70	71.20	122.50	141.30	149.30	209.40	13.10	15.10*g*	21.00	16.00	19.00
Montreal	72.20*a*	77.50*a*	142.50*at*	76.00*a*	165.80*a*	248.70	20.75	28.00	23.50	17.00	1.75*o*
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00	193.30*h*	238.80*h*	295.60*h*	13.00	.....	20.00	14.00	18.00
Philadelphia	80.50	85.90	161.10	193.30	238.80	296.60	15.00*s*	18.00*s*	15.50*q*	9.55*q*	12.05*q*
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55*m*
St. Louis	62.00	88.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30*m*
San Francisco	84.00	94.50	225.00	.....	.....	.....	14.00	17.00	.55*o*	.40*o*	2.05*m*
Seattle	100.00	110.00	220.00	.....	.....	.....	17.50*f*	17.50*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

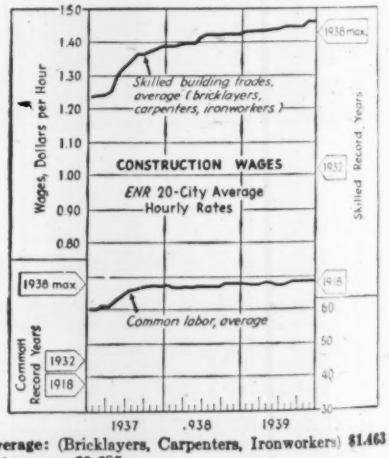
	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry *a*	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$9.25	$13.125	$1.30	$2.25	$1.20	$1.71	$1.65	$1.65	$0.36	$26.00
Baltimore	9.00	12.75	1.70	2.45	1.95	2.20	2.75	2.75	.45	27.50
Birmingham	9.25	13.125	2.35	2.35	1.85	1.84	1.73	1.73	.45	27.00
Boston	9.00	12.75	1.70‡	2.20‡	1.75‡	1.70‡	1.80*h*‡	1.80*h*‡	.45‡	20.00‡
Chicago	9.00	12.75	1.96	2.63	1.68	1.40*h*f	1.53*h*f	1.53*h*f	.26f	21.00f
Cincinnati	9.00	12.75	1.65	2.85	1.55	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	9.00	12.75	1.90	2.60	1.40	1.58	1.45*h*	1.45*h*	.35	21.00
Dallas	9.00	13.50	1.88	2.11	....	2.75*h*	2.60*h*	2.70*h*	.60	.....
Denver	9.50	13.25	1.65	2.40	.171	2.45	4.00	3.00	.35	18.00
Detroit	9.00	12.75	2.00	3.00	1.75	2.40	2.75	2.75	.35	27.50
Kansas City	9.00	12.875	2.15*g*	2.40*g*	1.67*g*	1.93	2.09	2.09	.25	25.00
Los Angeles	9.25	13.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	9.00	12.875	....	....	....	1.58*i*	1.45*h*i	1.45*h*i	.29	21.00
Montreal	9.25	9.00	2.25	2.80	2.35	2.53	1.68	1.78	.70	1.688
New York	9.00	12.75	1.88	2.55	1.60	1.63	1.45*h*	1.45*h*	.23	24.00
Philadelphia	9.00	12.75	....	....	....	1.92*e*	1.99*he*	1.99*he*	.41*e*	21.00
Pittsburgh	9.00	12.75	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	9.00	12.75	1.90/2.00	2.60/2.85	1.60/2.00	1.50	1.45	1.45	.24	21.00
San Francisco	9.25	13.00	1.80	2.75	1.10/2.00	1.66	1.90	1.90	.325	20.50
Seattle	9.25	13.25	1.80	2.60	....	1.81	1.30/2.00	1.75	.35	28.00*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3–49A. *c* ASTM Spec. D266–31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* per 100 lb. *l* per lb.

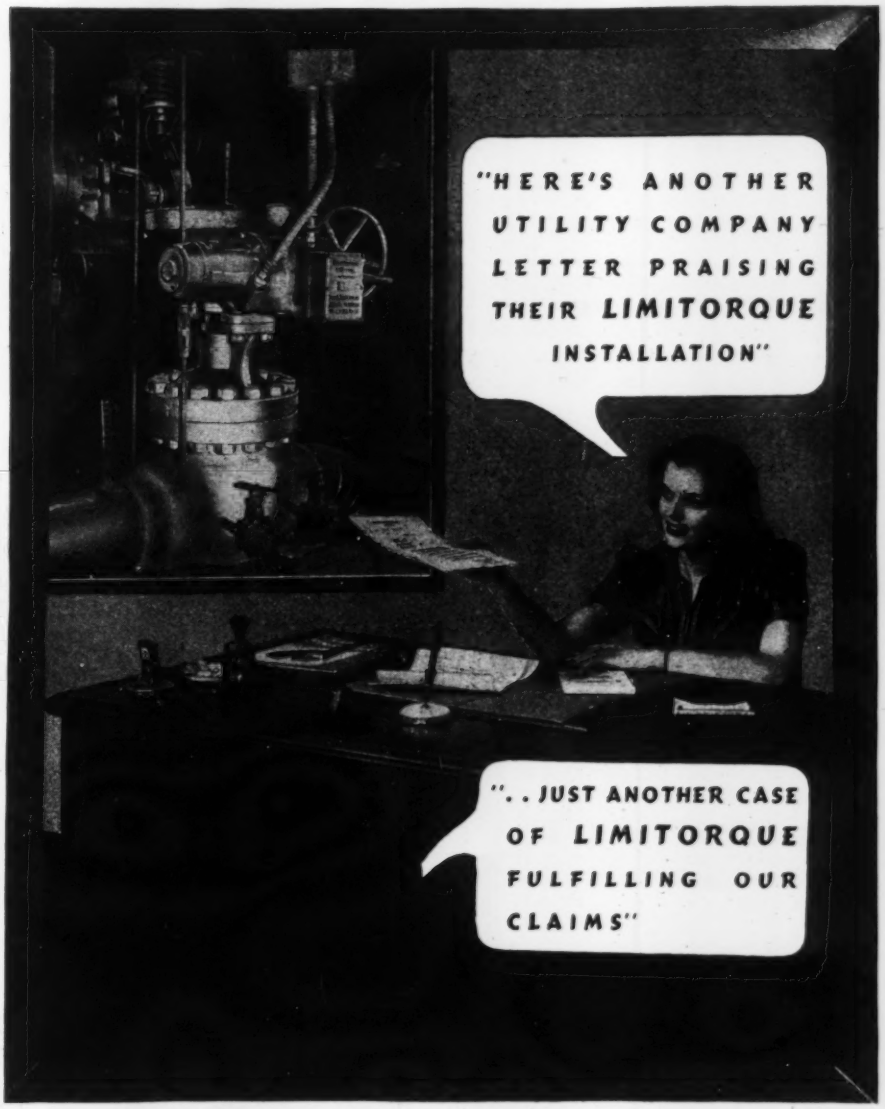
SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.25	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40*a*	.30/.40*a*
Boston	1.50	1.375	1.50	1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.525	1.00/1.525	1.625	.60/.75	.60/.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65*b*	1.50*b*	1.43*b*	....	1.50*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.75	.60/.75
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*e*	.85	.85
New Orleans	1.50	1.20	1.50	1.50	1.40	.40	.40
New York	1.90*b*	1.75*b*	1.925	2.00*b*	2.00*c*	1.031	.875/.95
Philadelphia	1.65*b*	1.25	1.65	1.50	1.565	.60	.60
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.25	1.75	1.57/2.00	1.58	.45/.875	.45/.875
San Francisco	1.75*c*	1.25*f*	1.50	1.50	1.60*c*	.81	.65
Seattle	1.60*c*	1.25	1.50*c*	1.50*c*	1.60*c*	.90*c*	.90*c*
Montreal	.80	.70	.75	.65	.80	.45	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) **$1.463**
ENR Common Average: $0.685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". . JUST ANOTHER CASE OF LIMITORQUE FULFILLING OUR CLAIMS"

Philadelphia LIMITORQUE CONTROL
operates all types of valves, etc., safely, economically, from convenient stations.
Philadelphia WORM GEAR SPEED REDUCER
right angle drives—vertical or horizontal. Wide range of ratios and horsepowers.
Philadelphia HERRINGBONE SPEED REDUCER
for heavy loads at high speed. Single, Double, Triple Reductions, various ratios and horsepowers.
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• Philadelphia Limitorque Controls save in many ways . . . one man can operate valves up to 94" diameter simply by stepping to a convenient control station and pushing a button. They save time . . . Limitorque operation is faster than manual, within practical limitations. Limitorque removes danger to valve parts and to employees also. Limitorque is dependable in emergencies . . . a fact proven by the many Central Stations, Central Heating Plants, Private Power Plants, etc., now using it.

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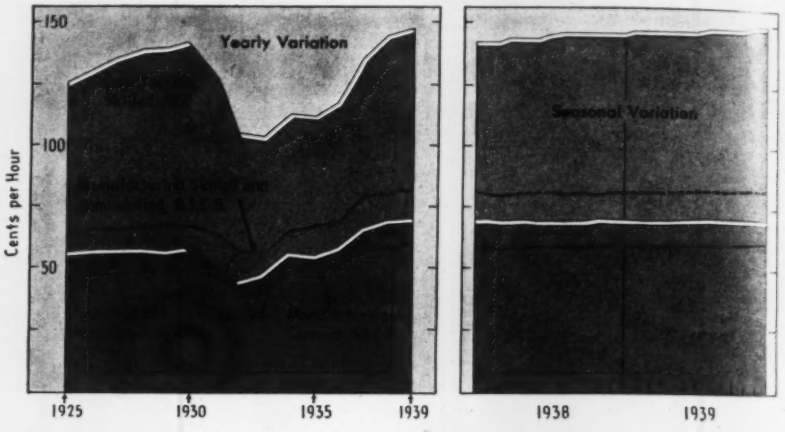
Construction Wage Rates and Trends

CONSTRUCTION wage averages in the common labor field stayed within a range of 0.5c. in 1939. The lowest 20-cities' hourly average rate during the year, 68c., was reported in February. This rate was unchanged in March. By August it had climbed to 68.5c., the level at which it remained for the rest of the year. The net result was a new record average hourly rate of 68.3c. for 1939, 0.7 per cent gain over 1938, the former all-time high.

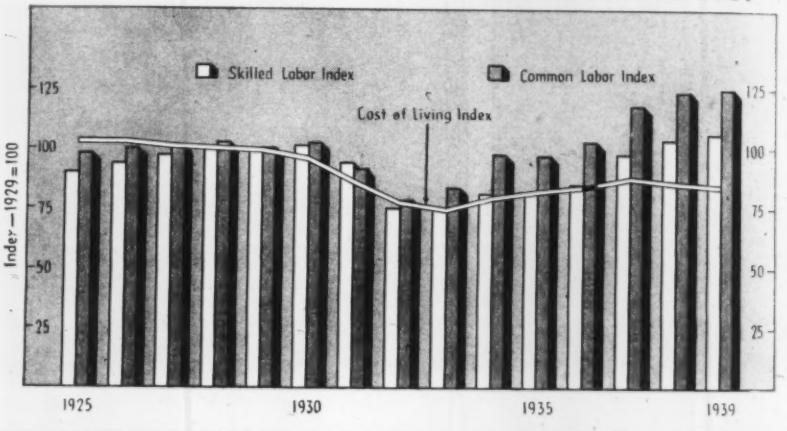
The skilled construction average rate for 20 cities revealed a wider gain than in the common field. All three trades combined to make up the skilled average wage showed increases over last year; bricklayers' and carpenters' rates were each up 1.9 per cent, and structural ironworkers', up 2.6 per cent. The overall gain for skilled construction labor was 2.1 per cent. The 1939 skilled labor average rate, $1.443, was the highest ever reported by *ENR*.

Real income, that is actual wages in relation to living costs, continued to improve for construction workers. The 1939 index of wage rates for the construction industry based on 1929 as 100 stood at 125 for common labor and 106 for skilled, increases of 0.7 and 2.1 per cent, respectively, over 1938.

CONSTRUCTION LABOR RATES CONSTANT



CONSTRUCTION WAGES EXTEND GAINS OVER LIVING COST



Construction Wages—Rates per Hour

20 Cities Average Reported by Engineering News-Record

	Construction Wages	
	Skilled Aver.†	Common
1910	$0.525	$0.179
1911	.534	.179
1912	.542	.182
1913	.555	.19
1914	.565	.177
1915	.57	.182
1916	.58	.192
1917	.61	.281
1918	.68	.38
1919	.78	.466
1920	1.05	.579
1921	1.06	.54
1922	1.01	.442
1923	1.10	.518
1924	1.19	.555

NOTES:

† *ENR* Skilled Average represents rates for bricklayers, carpenters, iron workers.

(1) Skilled and Semi-skilled.

(2) Unskilled.

Both represent earnings per hour as reported by N. I. C. B.

* Checked monthly. Reported in first issue of *ENR* each month.

Skilled Labor†*

	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
J	$1.21	$1.24	$1.28	$1.34	$1.35	$1.37	$1.37	$1.15	$0.989	$1.054	$1.108	$1.119	$1.22	$1.39	$1.43	$1.47
F	1.21	1.24	1.32	1.34	1.35	1.38	1.37	1.11	.996	1.062	1.104	1.119	1.24	1.39	1.43	1.47
M	1.21	1.24	1.32	1.34	1.35	1.38	1.36	1.11	.991	1.069	1.092	1.132	1.25	1.40	1.43	1.47
A	1.22	1.25	1.30	1.35	1.35	1.38	1.36	.95	.997	1.084	1.093	1.134	1.26	1.40	1.44	1.47
M	1.22	1.26	1.31	1.36	1.35	1.38	1.36	.96	.998	1.101	1.081	1.138	1.30	1.40	1.44	1.47
J	1.23	1.27	1.33	1.35	1.36	1.38	1.32	.99	.994	1.101	1.074	1.138	1.33	1.41	1.44	1.47
J	1.22	1.27	1.33	1.35	1.36	1.38	1.23	1.00	.985	1.104	1.077	1.150	1.35	1.43	1.44	
A	1.23	1.28	1.34	1.35	1.37	1.39	1.19	.98	.986	1.110	1.088	1.159	1.37	1.43	1.44	
S	1.23	1.28	1.34	1.35	1.37	1.39	1.19	.99	1.016	1.119	1.088	1.159	1.37	1.43	1.44	
O	1.23	1.29	1.33	1.35	1.37	1.39	1.17	.98	1.029	1.120	1.104	1.176	1.38	1.43	1.44	
N	1.23	1.29	1.34	1.35	1.37	1.39	1.16	.97	1.037	1.120	1.101	1.178	1.38	1.43	1.46	
D	1.24	1.29	1.33	1.35	1.37	1.39	1.15	.98	1.062	1.120	1.101	1.180	1.39	1.43	1.46	
Aver.	**1.22**	**1.27**	**1.32**	**1.35**	**1.36**	**1.38**	**1.27**	**1.02**	**1.006**	**1.097**	**1.093**	**1.149**	**1.32**	**1.41**	**1.44**	
Mfg. (1)	.644	.651	.656	.659	.668	.662	.634	.559	.55	.642	.662	.685	.78	.80	.81	

Common Labor*

	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
J	$0.55½	$0.54	$0.55½	$0.55	$0.559	$0.5628	$0.5384	$0.4524	$0.4271	$0.5158	$0.5376	$0.547	$0.603	$0.680	$0.682	$0.685
F	.54	.54	.55½	.54½	.564	.5628	.5428	.4521	.4285	.5268	.5241	.547	.603	.675	.680	.685
M	.54½	.54½	.56	.54½	.5509	.5610	.5571	.4358	.4272	.5268	.5243	.547	.612	.675	.680	.685
A	.54½	.54½	.56	.55	.529	.5646	.5359	.4122	.4343	.5343	.5255	.552	.612	.677	.683	.685
M	.54	.55	.55½	.55	.5315	.5628	.5394	.4105	.4442	.5343	.5233	.558	.627	.673	.682	.690
J	.53	.55	.55½	.55½	.534	.5628	.5394	.4121	.4393	.5343	.5269	.564	.644	.677	.684	.703
J	.53	.55½	.55½	.55½	.5296	.5615	.4721	.4114	.4430	.5300	.5289	.563	.662	.677	.684	
A	.53	.55½	.55½	.5607	.5353	.5615	.4634	.4220	.4430	.5300	.5285	.569	.668	.677	.685	
S	.53	.55½	.55½	.5607	.5496	.5609	.4665	.4308	.4524	.5349	.5285	.569	.673	.677	.685	
O	.54	.55	.54½	.5628	.5496	.5596	.4584	.4308	.5057	.5363	.5285	.583	.676	.682	.685	
N	.54	.55½	.54½	.5653	.5603	.5587	.4559	.4260	.5102	.5388	.5275	.583	.678	.682	.685	
D	.54	.55½	.55	.5628	.5653	.5503	.4534	.4273	.5202	.5413	.5275	.586	.678	.682	.685	
Aver.	**.555**	**.538**	**.548**	**.554**	**.5558**	**.5465**	**.5007**	**.5002**	**.4269**	**.4562**	**.5319**	**.5276**	**.564**	**.645**	**.683**	
Mfg. (2)	.459	.455	.461	.472	.474	.486	.478	.461	.401	.401	.478	.494	.498	.568	.594	

Still on the Job

...AFTER 4½ YEARS' SERVICE IN HIGHLY CORROSIVE WATER

● Before the advent of turbine pumps, an Evansville, Indiana, plant obtained its cooling water from deep wells, using plunger pumps. But Evansville well water is very corrosive on ferrous materials and, due to the trouble it caused, the deep wells were abandoned for a spray pond. In the Fall of 1935, the deep wells were again placed in commission, the engineer in charge using turbine pumps with Republic Toncan* Iron for column, shaft, casing, tubing and the discharge line.

This Spring, when two of the pumps were inspected, no repairs were required and the pipe was in such excellent condition that it was put back into the wells.

Toncan Iron is made of an alloy of highly refined open-hearth iron, copper and molybdenum. Engineers who have used it where corrosion is a problem know that it possesses the highest rust-resistance of the ferrous metals in its price class. It is a money-saver for municipalities and industrial plants, and has established enviable records for service in water mains, filtration plants, swimming pools, sewage disposal plants, boiler rooms and plant service and processing lines.

Ask for a copy of Booklet No. 333 for more complete data. Write Republic Steel Corporation, General Offices, Cleveland, Ohio.

*Reg. U. S. Pat. Off.

REPUBLIC STEEL
REG. U. S. PAT. OFF.

BERGER MANUFACTURING DIVISION
NILES STEEL PRODUCTS DIVISION
STEEL AND TUBES DIVISION
UNION DRAWN STEEL DIVISION
TRUSCON STEEL COMPANY

TONCAN IRON PIPE

Made of an alloy of refined open-hearth iron, copper and molybdenum
—that grows old slowly

Wage Rates per Hour
New York City

	Carpenters, 10 Hr. Day	Bricklayers, 8 Hr. Day	Masons' Laborers, 8 Hr. Day	Common Laborers, 10 Hr. Day	Structural Iron-Workers
1874	$0.23	$0.43	$0.18	$0.14	.....
1875	.22½	.37	.18	.14	.....
1876	.21	.31	.17	.14	.....
1877	.20	.31	.15	.12	.....
1878	.18	.31	.15	.11	.....
1879	.17	.31	.16	.11	.....
1880	.18	.34	.18	.12	.....
1881	.19	.46	.21	.13	.....
1882	.21	.50	.22	.15	.....
1883	.21	.50	.23	.13	.....
1884	.21	.50	.22	.13	.....
1885	.20	.50	.22	.13	.....
1886	.21	.50	.23	.13	.....
1887	.21	.50	.20	.14	.....
1888	.22	.50	.16	.12	.....
1889	.22	.50	.23	.13	.....
	8 Hr. Day			9 Hr. Day	
1890	.43	.47	.28	.14	.....
1891	.43	.47	.28	.14	.....
1892	.44	.50	.29	.14	.....
1893	.43	.50	.30	.14	.....
1894	.44	.50	.30	.14	.....
1895	.43	.50	.30	.14	.....
1896	.44	.50	.30	.14	.....
1897	.44	.50	.29	.14	.....
1898	.44	.50	.30	.14	.....
1899	.45	.55	.33	.14	.....
1900	.50	.56	.33	.14	.....
1901	.50	.59	.33	.19	.....
1902	.51	.65	.36	.17	.....
1903	.56	.65	.36	.16	.....
1904	.53	.65	.36	.19	.....
1905	.54	.70	.36	.20	.....
1906	.58	.70	.38	.21	.....
				—8 Hr. Day—	
1907	.62½	.70	.37½	.22	$0.60
1908	.62½	.70	.37½	.22	.60
1909	.62½	.70	.37½	.22	.60
1910	.62½	.70	.37½	.22	.62½
1911	.62½	.70	.37½	.22	.62½
1912	.62½	.70	.37½	.23	.62½
1913	.62½	.70	.37½	.22½	.62½
1914	.62½	.75	.37½	.22½	.62½
1915	.62½	.75	.37½	.25	.62½
1916	.62½	.75	.37½	.25	.66
1917	.69	.75	.42½	.30	.68
1918	.69	.81	.47	.40½	.80
1919	.75	.87½	.57½	.40½	.87½
1920	1.12½	1.25	.77½	.75	1.12½
1921	1.12½	1.25	.87½	.60	1.12½
1922	1.12½	1.25	.87½	.60	1.12½
1923	1.12½	1.50	.95	.61½	1.12½
1924	1.31½	1.50	1.00	.68½	1.29
1925	1.31½	1.50	1.00	.65½	1.46½
1926	1.45	1.64½	1.07	.81½	1.60
1927	1.50	1.75	1.12½	.90½	1.75
1928	1.50	1.75	1.12½	.90½	1.75
1929	1.55	1.84	1.15	.98½	1.81
1930	1.65	1.92½	1.03½	1.03½	1.92½
1931	1.45	1.71½	1.02½	.65½	1.92½
1932	1.33	1.47	1.00	.64½	1.67½
1933	1.37½	1.57½	.91	.72½	1.65
1934	1.40	1.53	.82½	.84½	1.62
1935	1.40	1.50	.82½	.68	1.65
1936	1.40	1.50	.82½	.65	1.58
1937	1.60	1.73	.91	.76	1.79
	—7 Hr. Day—				
1938	1.75	1.88½	.99½	.91½	1.92½
1939	1.75	1.89½	1.03½	.91½	1.92½
	1938 by Months				
Jan.	1.75	1.88½	.95	.87½/.95	1.92½
Feb.	1.75	1.88½	.95	.87½/.95	1.92½
Mar.	1.75	1.88½	.95	.89½/.95	1.92½
Apr.	1.75	1.88½	.95	.87½/.95	1.92½
May	1.75	1.88½	.95	.87½/.95	1.92½
June	1.75	1.88½	1.03	.87½/.95	1.92½
July	1.75	1.88½	1.03	.87½/.95	1.92½
Aug.	1.75	1.88½	1.03	.87½/.95	1.92½
Sept.	1.75	1.88½	1.03	.87½/.95	1.92½
Oct.	1.75	1.88½	1.03	.87½/.95	1.92½
Nov.	1.75	1.88½	1.03	.87½/.95	1.92½
Dec.	1.75	1.88½	1.03	.87½/.95	1.92½
	1939 by Months				
Jan.	1.75	1.88½	1.03½	.87½/.95	1.92½
Feb.	1.75	1.88½	1.03½	.87½/.95	1.92½
Mar.	1.75	1.88½	1.03½	.87½/.95	1.92½
Apr.	1.75	1.88½	1.03½	.87½/.95	1.92½
May	1.75	1.88½	1.03½	.87½/.95	1.92½
June	1.75	1.88½	1.03½	.87½/.95	1.92½
July	1.75	1.90	1.03½	.87½/.95	1.92½
Aug.	1.75	1.90	1.03½	.87½/.95	1.92½
Sept.	1.75	1.90	1.03½	.87½/.95	1.92½
Oct.	1.75	1.90	1.03½	.87½/.95	1.92½
Nov.	1.75	1.90	1.03½	.87½/.95	1.92½
Dec.	1.75	1.90	1.03½	.87½/.95	1.92½
	1940 by months				
Jan.	1.75	1.90	1.03½	.87½/.95	1.92½
Feb.	1.75	1.90	1.03½	.87½/.95	1.92½
Mar.	1.75	1.90	1.03½	.87½/.95	1.92½
Apr.	1.75	1.90	1.03½	.87½/.95	1.92½
May	1.75	1.90	1.03½	.87½/.95	1.92½
June	1.85	2.00	1.03½	.87½/.95	1.92½

INDEX OF UNION HOURLY WAGE RATES IN BUILDING TRADES (1929 = 100)

Industrial Relations Division
U. S. Department of Labor, Bureau of Labor Statistics

Year	All Building Trades	Journeymen	Helpers & Laborers	Bricklayers	Carpenters	Cement Finishers	Electricians (Inside Wiring)	Engineers (Portable & Hoisting)	Glaziers	Lathers	Painters	Plasterers	Plumbers & Gas Fitters	Sheet-Metal Workers	Steam & Sprinkler Fitters	Stonemasons	Structural Ironworkers	Building Laborers	Hod Carriers
1907	31.5	31.7	30.7	37.9	32.0	38.5	31.3	.....	.....	.....	27.5	39.9	37.8	33.8	33.8	34.7	31.8	32.0	33.1
1908	33.5	33.8	32.1	38.9	34.0	38.4	34.2	.....	.....	.....	30.5	39.8	38.2	34.5	34.2	35.2	34.7	35.2	33.2
1909	35.1	35.5	33.2	39.7	35.9	39.6	35.3	.....	.....	.....	32.6	40.1	38.8	34.7	38.9	35.3	37.2	35.3	33.3
1910	36.5	37.0	34.3	40.4	37.6	40.0	36.3	.....	.....	.....	34.6	40.5	39.1	35.7	36.1	35.6	39.5	36.7	33.8
1911	37.1	37.6	34.5	40.4	38.1	41.5	36.7	.....	.....	.....	35.3	40.8	41.4	36.8	37.3	36.0	40.5	36.8	34.1
1912	37.9	38.5	34.8	41.0	38.9	41.5	37.1	41.8	.....	39.4	35.7	41.6	41.6	37.6	37.9	36.4	41.2	37.2	34.3
1913	38.8	39.4	35.8	41.7	39.5	42.5	37.9	43.0	.....	40.3	37.3	42.0	43.0	39.3	39.3	37.6	42.5	38.4	34.8
1914	39.6	40.3	36.2	42.8	40.1	42.9	39.1	43.6	.....	41.0	38.5	42.2	43.6	40.7	40.0	38.7	43.3	39.2	35.2
1915	39.9	40.6	36.5	42.9	40.6	43.3	39.9	43.6	.....	41.5	38.7	42.4	43.9	41.3	40.9	39.1	43.3	39.4	35.4
1916	41.2	42.0	37.7	43.3	41.8	43.7	40.7	44.1	.....	42.7	42.3	43.9	44.3	42.0	41.7	39.7	44.0	41.2	36.5
1917	43.8	44.3	41.4	44.8	45.5	46.2	43.3	46.5	.....	44.4	43.6	45.2	45.8	43.8	43.3	41.2	46.6	45.5	40.7
1918	48.6	49.0	48.0	48.1	50.5	51.0	48.2	53.2	45.9	47.9	48.1	47.6	50.6	51.3	47.3	45.2	53.4	53.4	47.5
1919	55.7	56.0	55.5	53.4	58.2	57.2	55.2	58.3	49.1	53.3	56.3	54.9	57.2	56.6	53.2	50.7	60.1	60.5	55.6
1920	75.2	74.9	80.5	72.8	77.8	77.7	72.8	75.5	71.0	76.0	76.7	71.7	74.0	75.9	70.2	70.7	76.2	87.7	80.8
1921	76.6	76.3	81.3	72.3	78.4	80.3	75.4	76.7	72.2	77.2	78.9	75.6	77.4	78.7	71.1	72.4	77.6	88.2	81.2
1922	71.8	71.9	74.0	70.4	72.7	74.5	71.1	72.2	72.4	72.5	73.8	72.7	71.9	73.0	69.5	67.4	70.5	82.8	67.5
1923	79.4	79.2	78.5	79.7	81.0	81.5	73.8	79.8	76.7	80.1	81.0	81.0	79.4	78.6	72.9	79.7	75.1	84.4	73.8
1924	85.7	85.6	84.9	84.3	86.7	90.1	82.4	84.8	80.9	86.4	85.3	90.6	86.6	86.3	83.6	84.5	85.0	93.9	76.8
1925	89.0	88.8	87.7	89.2	88.5	90.6	86.7	88.5	90.0	94.2	90.0	92.1	88.4	89.2	88.0	86.1	85.9	89.7	85.5
1926	94.8	94.7	95.6	94.7	95.0	96.7	91.3	93.4	91.2	96.6	95.4	98.9	95.2	95.3	95.3	94.9	92.4	98.7	93.3
1927	98.1	97.9	97.3	97.0	98.1	101.0	95.1	96.4	97.4	100.5	98.6	101.1	97.2	98.2	98.0	96.1	99.0	99.1	95.7
1928	98.7	98.7	98.3	97.8	98.4	100.0	96.0	100.4	98.5	100.8	100.2	101.2	99.2	96.3	99.4	97.3	99.2	99.5	95.8
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1930	104.2	104.1	105.1	102.4	104.0	106.6	101.8	107.7	104.6	104.3	105.6	105.0	103.9	104.6	104.9	101.5	105.5	105.5	103.8
1931	104.5	104.5	104.5	102.2	104.2	107.0	103.2	107.7	105.3	103.7	106.1	104.7	105.1	106.2	105.5	102.0	106.5	103.9	103.5
1932	89.3	89.3	89.2	87.5	85.4	93.4	98.5	100.7	88.2	93.1	89.6	87.1	91.4	92.1	90.9	90.5	92.3	89.4	85.8
1933	86.8	86.9	85.2	85.2	85.2	91.2	89.9	99.6	88.0	89.7	87.8	83.7	90.6	89.4	88.2	84.5	91.3	84.2	84.7
1934	87.4	87.4	87.7	84.5	86.7	92.1	90.1	101.4	93.2	92.1	86.4	84.6	1.4	89.7	89.2	84.4	92.5	87.3	90.3
1935	88.4	88.4	88.2	84.2	87.8	92.6	94.4	103.1	94.1	93.1	86.7	85.6	92.8	90.4	90.7	84.2	93.2	88.6	87.4
1936	91.6	91.4	93.4	84.7	92.3	95.0	96.9	104.2	95.5	95.5	91.1	86.1	95.2	92.2	93.7	85.2	95.6	96.2	92.1
1937	98.0	97.6	101.5	90.6	98.3	101.9	101.1	112.6	104.6	101.8	97.7	94.9	100.4	98.9	98.8	94.1	104.4	105.3	99.1
1938	106.7	106.1	111.7	100.1	107.1	111.3	111.4	116.0	112.2	112.7	104.2	106.1	112.5	108.8	111.4	102.1	113.2	112.9	109.1
1939	107.4	106.8	112.6	100.6	107.3	111.7	112.0	117.4	113.0	116.4	105.0	107.0	113.5	110.4	112.2	102.4	114.5	113.6	109.4

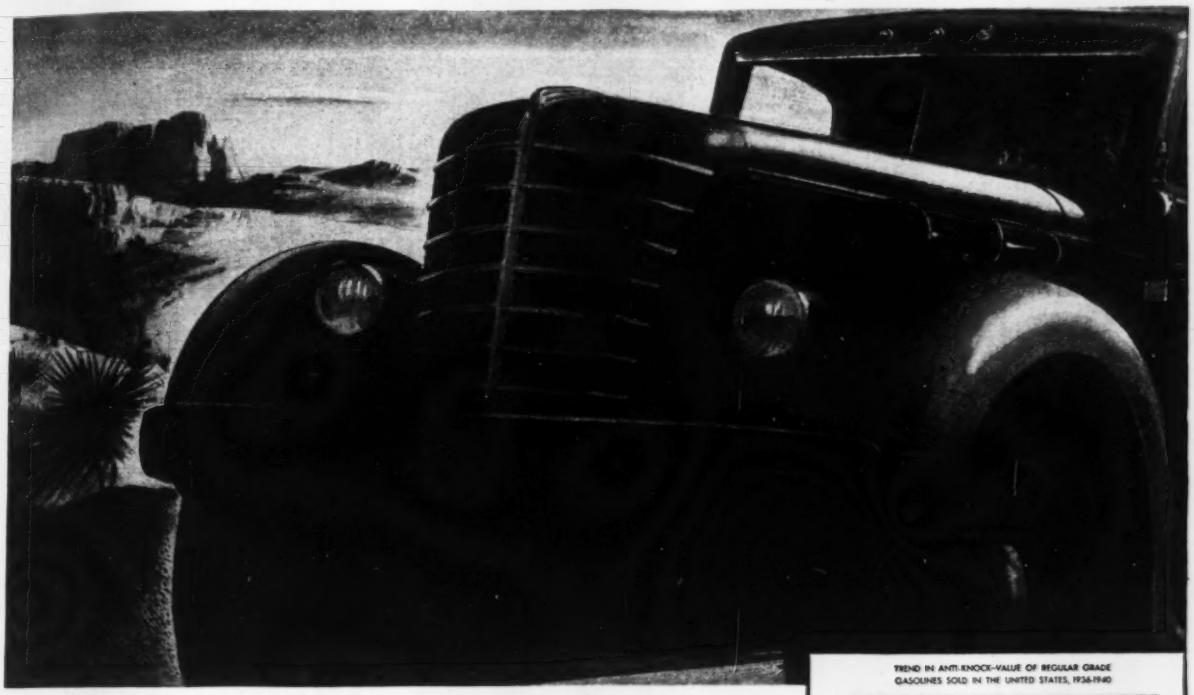
INDEX OF WEEKLY HOURS IN UNION BUILDING TRADES (1929 = 100)

Industrial Relations Division
U. S. Department of Labor, Bureau of Labor Statistics

Year	All Building Trades	Journeymen	Helpers & Laborers	Bricklayers	Carpenters	Cement Finishers	Electricians (Inside Wiring)	Engineers (Portable & Hoisting)	Glaziers	Lathers	Painters	Plasterers	Plumbers & Gas Fitters	Sheet-Metal Workers	Steam & Sprinkler Fitters	Stonemasons	Structural Ironworkers	Building Laborers	Hod Carriers
1907	110.0	109.3	113.1	112.0	107.2	109.1	110.3	.....	.....	.....	114.1	108.8	104.7	105.4	105.9	106.8	108.1	108.5	110.5
1908	108.3	107.7	110.8	109.6	105.6	108.1	109.5	.....	.....	.....	112.3	108.3	104.8	105.3	105.9	106.8	105.9	108.5	110.5
1909	106.8	106.4	108.5	107.3	104.4	108.9	108.8	.....	.....	.....	110.7	108.3	104.8	105.3	105.6	106.8	104.5	108.1	110.1
1910	105.5	105.2	106.6	105.3	103.1	108.7	108.2	.....	.....	.....	109.3	108.2	104.6	105.3	105.0	105.2	103.4	105.5	109.2
1911	105.1	104.8	106.4	104.9	102.6	107.7	108.0	.....	.....	.....	108.6	108.8	104.3	105.0	104.9	104.5	103.2	105.5	108.6
1912	104.8	104.5	106.1	104.9	102.5	107.7	107.6	105.6	.....	104.0	108.5	107.5	103.5	103.7	104.2	104.5	102.1	105.5	107.8
1913	104.6	104.2	106.0	104.7	102.4	106.5	107.2	104.1	.....	104.0	107.9	107.5	103.5	103.5	103.8	104.4	101.7	105.5	107.8
1914	104.2	103.9	105.5	104.2	102.0	105.8	106.8	104.0	.....	104.0	107.6	107.4	103.1	103.4	102.5	104.4	101.5	105.2	106.4
1915	104.1	103.8	105.4	104.1	102.0	105.8	106.2	103.5	.....	103.5	107.6	106.9	103.1	103.2	102.5	104.3	101.5	105.2	106.4
1916	103.7	103.4	105.1	103.9	102.0	104.2	105.3	103.1	.....	103.5	106.9	105.8	102.6	102.8	102.2	104.1	101.2	104.6	106.4
1917	103.5	103.2	104.7	103.6	102.0	103.0	104.9	102.4	.....	103.0	106.8	105.7	102.5	102.7	102.1	104.0	101.0	103.5	106.3
1918	102.9	102.6	104.3	103.6	100.9	102.5	104.2	100.8	101.6	103.0	106.3	105.4	101.6	101.6	101.1	104.0	100.7	103.0	106.3
1919	102.4	102.2	103.3	103.4	100.3	101.7	103.3	100.3	101.6	102.7	106.1	105.4	101.3	101.2	101.0	103.4	100.5	101.1	105.9
1920	101.9	101.7	102.7	103.3	100.4	101.2	103.0	99.8	101.2	102.1	103.0	105.2	101.3	100.8	100.9	103.4	100.5	100.0	105.7
1921	101.8	101.6	102.7	103.3	100.3	101.2	103.0	99.4	101.6	101.9	103.1	104.9	101.1	100.8	100.8	103.5	100.5	100.0	105.7
1922	101.8	101.7	102.4	103.3	100.4	101.1	103.0	99.1	101.7	102.0	103.9	105.0	101.1	100.7	100.8	103.4	100.5	99.3	105.9
1923	101.9	101.8	102.6	103.3	100.7	101.1	103.0	98.7	101.2	102.3	103.6	105.5	101.1	100.7	100.8	103.4	100.5	100.0	105.9
1924	101.9	101.8	102.6	103.2	100.6	101.1	102.9	98.7	101.2	102.1	103.5	105.6	101.1	100.7	100.8	103.1	100.5	97.7	105.8
1925	101.9	101.8	102.4	103.1	100.6	100.8	102.9	99.0	100.8	101.8	103.8	105.3	101.1	100.7	100.8	103.1	100.2	99.8	105.7
1926	101.7	101.6	102.2	103.2	100.6	100.8	102.9	99.2	101.2	101.5	103.4	102.2	101.1	100.7	100.7	103.3	100.5	100.0	105.8
1927	101.5	101.4	102.2	102.7	100.6	100.5	102.9	100.8	101.5	101.0	103.0	101.8	100.9	100.4	100.5	103.1	100.5	100.2	105.8
1928	100.9	100.7	102.1	102.0	100.0	99.9	102.4	99.7	101.1	100.5	100.3	100.9	100.9	100.1	100.5	103.0	100.4	100.1	105.8
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1930	97.2	97.1	97.8	97.1	96.9	96.1	97.6	95.1	96.8	94.3	98.9	97.7	95.4	96.3	95.5	96.6	96.9	98.1	99.3
1931	96.0	95.8	97.0	96.	95.4	95.0	96.6	93.7	95.1	93.8	98.0	97.0	94.1	94.7	94.5	94.9	95.8	97.0	98.8
1932	94.3	94.1	94.8	93.9	93.0	93.9	94.3	92.6	92.9	93.3	97.9	95.2	93.7	93.3	93.6	94.5	93.4	93.6	96.6
1933	94.0	93.8	94.4	94.9	91.6	95.7	94.3	91.7	92.9	92.9	97.7	97.2	93.3	93.2	93.1	93.8	93.1	93.2	96.1
1934	90.5	90.3	91.4	93.3	90.8	92.2	88.7	89.7	88.1	87.5	85.6	93.1	92.4	91.9	92.5	93.4	91.8	89.1	94.3
1935	89.8	89.7	90.8	93.2	90.4	92.0	85.1	89.2	87.5	87.4	85.5	91.6	91.8	92.0	92.2	93.3	90.7	89.0	94.2
1936	89.8	89.6	91.0	93.2	90.5	91.6	85.4	89.7	87.8	86.5	85.9	90.1	90.6	91.9	92.4	93.3	90.6	89.5	94.0
1937	90.2	90.0	91.3	94.1	90.3	91.7	89.6	89.5	87.9	87.7	85.9	90.2	91.1	92.0	92.5	93.3	90.2	89.7	94.3
1938	88.7	88.4	89.9	91.0	88.6	88.9	89.1	89.3	86.3	86.1	86.0	86.5	86.5	86.5	90.1	87.6	90.2	89.5	89.3
1939	88.5	88.3	89.7	91.1	88.6	88.9	88.8	89.2	86.1	85.4	85.7	86.5	86.8	90.1	88.0	90.2	89.4	89.2	92.9

CLUE TO ECONOMY

More efficient use of fuel through higher compression ratios results in 9% to 17% lower fuel consumption in 95,000-mile series of commercial vehicle tests.



TESTS WITH HIGH AND LOW compression ratios in commercial vehicles, covering a two-year period, were recently completed at the San Bernardino, California, laboratory of the Ethyl Gasoline Corporation.

Every fleet owner should be interested in the facts about fuel consumption and trip time gathered from these tests.

WHAT TESTS PROVED: With the higher compression ratio, fuel consumption was decreased 9% to 17% with the vehicle carrying the same gross loads over identical test routes. In addition, trip time to travel various test routes was reduced 7% to 8% with the higher ratio. This would mean a substantial saving in cost of driver's time for a given trip—more goods or passengers hauled per unit of time, and therefore smaller charges against each ton mile or passenger mile for fixed costs.

YOUR CLUE: With the increase in the average anti-knock rating of gasoline today, many truck and bus operators reduce fuel consumption and trip time by:

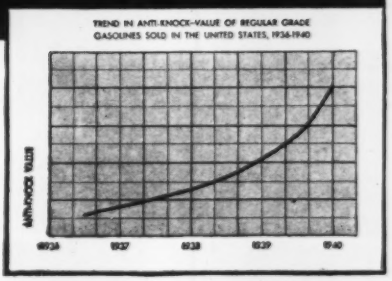
1. Installing high compression pistons or cylinder heads (as supplied by the manufacturer) in older engines when engines are overhauled or rebuilt.

2. Advancing the spark as far toward maximum power as today's better gasolines will permit in vehicles with high compression engines.

3. Investigating available compression ratios when purchasing new equipment and specifying a ratio high enough to take full advantage of modern gasoline.

Increases in performance obtained in this way may also be used to haul heavier payloads or to operate on faster or more uniform schedules.

• *For detailed information as to how the tests mentioned above were made, the routes used and the results in fuel economy and time saving, send for the new, free booklet, "Results of Recent Road and Laboratory Tests on Commercial Engines." It's yours for the asking. Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y., manufacturer of anti-knock fluids used by oil companies to improve gasoline.*



MAIL COUPON FOR TEST RESULTS BOOKLET

Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y.

Please send me a copy of "Results of Recent Road and Laboratory Tests on Commercial Engines," which gives complete data on the San Bernardino tests.

Name_____

Address_____

_____

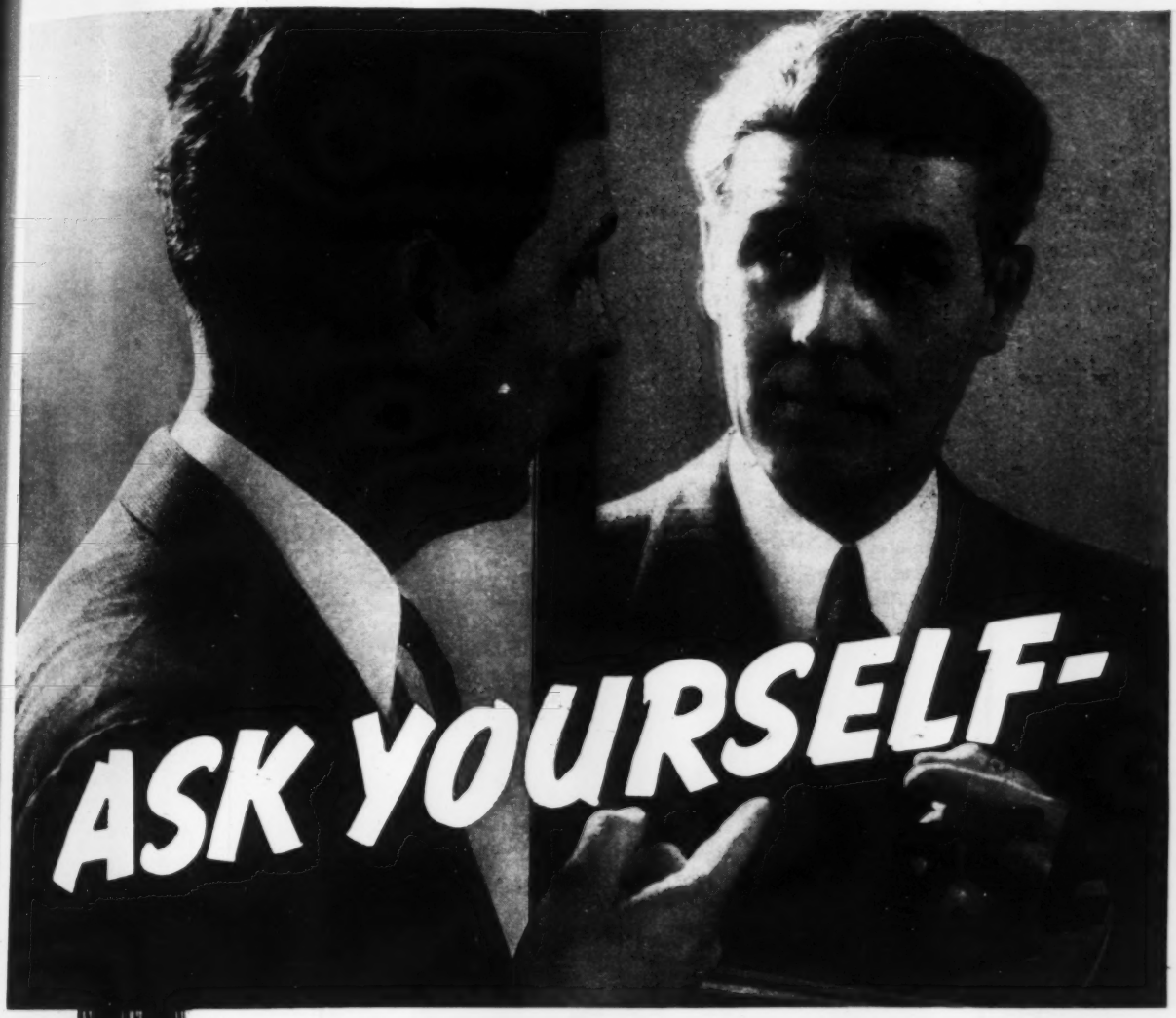
ENR-6

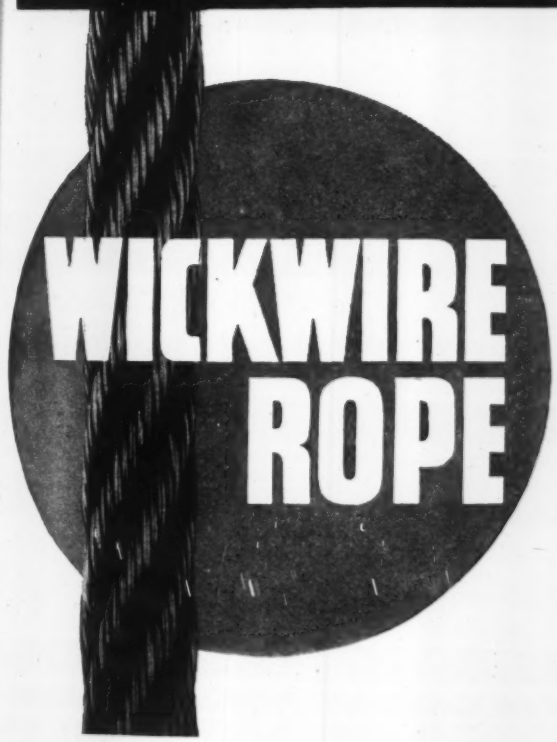
Building Trades Wage Rates Prevailing May 1, 1940

Compiled by Engineering News-Record

City and State	Carpenters	Bricklayers	Structural Ironworkers	Common Labor, Building	Common Labor, Hvy. Constr.	Stone Masons	Masons Helpers	Plasterers	Hoisting Engr. 1-Drum	Hoisting Engr. 2-Drum	Mosaic and Terrazzo	Tile Layers	Cement Finishers	Lathers	Electrical (Inside) Workers	Const. Equip. Operators	Shovel Oper., Power	Painters	Glaziers	Plumbers	Steam Fitters	Roofers	Waterproofers	Truck Drivers	Sheet Metal Workers
Albany, N. Y.	$1.18	$1.38*	$1.38*	$ .63*	$ .63	$1.38	$ .63	$1.38*	$1.55	$1.75	$1.25	$1.25	$1.38	$1.38*	$1.35	$1.50	$1.80	$1.12	$1.00	$1.38	$1.38	$1.20	$1.38	$ 63	$1.20
Ames, Iowa	1.15	1.50	1.38	.60	.60	1.50	.70	1.25	.75	.75	1.25	.75	1.00	1.38	1.38	1.00	1.00	.90	1.25	1.50	1.50	.90	.90	60	1.00
Atlanta, Ga.	1.00	1.38	1.38	.40	.40	1.38	.75	1.25	1.00	1.25	1.38	1.25	1.25	1.25	1.25	1.00	1.25	1.00	1.00	1.38	1.38	1.25	1.25	50	1.25
Austin, Tex.	1.13	1.50	1.25	.40	....	1.50	.50	1.50	1.00	1.25	1.50	1.50	1.25	1.50	1.25	....	1.25	1.00	1.00	1.25	1.25	1.00	....	70	1.00
Baltimore, Md.	1.25	1.50	1.65	.45	.45	1.50	.81	1.38	1.50	1.80	1.50	1.50	1.25	1.38	1.38	1.50	1.80	1.13	1.13	1.38	1.38	1.38	1.38	60	1.38
Birmingham, Ala.	1.13	1.50	1.50	.50	.60	1.50	.60	1.50	1.25	1.25	1.50	1.50	1.50	1.25	1.50	1.25	1.25	1.25	1.25	1.50	1.50	1.25	1.25	1 25	1.25
Bismarck, N. D.	.90	1.38	1.25	.50	.55	1.38	.65	1.25	1.00	1.25	1.25	1.38	1.00	1.00	.90	1.25	1.25	.90	.90	1.00	1.00	.65	.65	70	1.00
Boise, Idaho	1.00	1.38	....	.63	.63	....	.75	1.25	1.25	1.35	....	....	....	.63	1.00	....	1.50	1.00	1.00	1.00	1.00	....	....	63	....
Boston, Mass.	1.38	1.50	1.50	.85	.85	1.50	.85	1.67	1.38	1.38	1.50	1.50	1.45	1.67	1.50	1.63	1.63	1.25	1.38	1.50	1.50	1.50	1.50	75	1.50
Butte, Mont.	1.50	1.63	1.50	.80	.80	1.63	.91	2.00	1.16	1.16	....	....	2.00	1.63	1.67	....	1.50	1.37	....	2.00	2.00	1.25	....	1 16	1.50
Charleston, S. C.	.75	1.00	1.00	.40	.30	1.00	.50	1.00	.50	.75	1.00	1.00	1.00	.75	1.00	1.00	1.00	.75	.75	1.25	1.25	1.00	.75	75	1.00
Charleston, W. Va.	1.13	1.50	1.38	.50	.50	1.50	.68	1.38	1.13	1.13	1.25	1.25	1.10	1.25	1.38	1.25	1.38	1.00	1.00	1.25	1.25	1.13	.88	65	1.13
Chattanooga, Tenn.	1.25	1.50	1.50	.45	.60	1.50	.60	1.50	1.00	1.25	1.50	1.50	1.50	1.25	1.25	1.50	1.50	1.25	1.50	1.50	1.50	1.25	1.25	60	1.50
Cheyenne, Wyo.	1.25	1.50	1.25	.55	.55	1.50	1.00	1.50	1.25	1.25	1.25	1.50	1.25	1.25	1.25	1.00	1.13	1.13	1.25	1.25	1.25	1.25	1.00	1	1.25
Chicago, Ill.	1.63	1.70	1.70	1.03	1.03	1.70	1.43	1.70	1.70	1.70	1.63	1.63	1.63	1.70	1.70	....	2.00	1.67	1.94	1.70	1.70	1.75	....	....	1.70
Cincinnati, Ohio	1.45	1.63	1.55	.75	.75	1.63	.75	1.63	1.38	1.53	1.25	1.40	1.38	1.40	1.50	1.53	1.53	1.35	1.55	1.50	1.50	1.40	1.25	80	1.38
Cleveland, Ohio	1.38	1.63	1.63	.90	.90	1.63	.90	1.63	1.38	1.50	1.50	1.50	1.38	1.63	1.65	1.38	1.50	1.35	1.38	1.50	1.50	1.63	1.43	90	1.38
Columbia, S. C.	.88	1.00	1.25	.30	.30	1.00	.40	1.00	1.00	1.00	1.00	1.00	.75	.75	1.10	1.00	1.00	.75	.75	1.25	1.25	1.00	.75	50	.75
Columbus, Ohio	1.15	1.56	1.50	.55†	.65	1.45	.80	1.55	1.30	1.30	1.25	1.25	1.25	1.55	1.25	....	1.50	1.15	1.13	1.38	1.38	1.00	1.00	75	1.25
Conway, Ark.	.60	1.25	....	.40	.40	1.25	.35	1.25	....	....	....	1.50	1.25	.80	1.00	....	....	.60	.40	1.00	1.25	.60	.50	40	.75
Dallas, Tex.	1.00	1.38	1.38	.40	.40	1.38	.55	1.38	1.13	1.25	1.38	1.38	1.13	1.00	1.25	1.25	1.25	1.00	1.00	1.38	1.38	1.00	1.00	45	1.38
Denver, Colo.	1.43	1.65	1.43	.71	.71	1.25	....	1.50	1.43	1.50	1.43	1.50	1.43	1.50	1.50	1.50	1.50	1.25	1.20	1.43	1.43	1.35	1.35	75	1.50
Detroit, Mich.	1.25	1.50	1.63	.78	.78	1.50	1.00	1.55	1.50	1.63	1.44	1.50	1.25	1.55	1.65	1.63	1.63	1.25	1.25	1.50	1.50	1.25	1.25	75	1.25
Duluth, Minn.	1.13	1.25	1.50	.60	.60	1.25	.75	1.35	1.25	1.25	1.25	1.25	1.00	1.35	1.13	.75	1.40	1.00	.85	1.25	1.25	1.00	1.00	65	1.10
East Lansing, Mich.	1.13	1.13	1.63	.65	.60	1.13	.85	1.50	1.50	1.13	1.50	1.50	1.13	1.25	1.25	1.13	1.13	1.00	1.25	1.50	1.50	.90	1.13	75	1.00
Galesburg, Ill.	1.13	1.38	1.38	.70	.70	1.38	.80	1.38	1.38	1.50	....	....	1.25	1.25	1.25	1.50	1.50	1.00	1.15	1.25	1.25	1.00	1.00	80	1.10
Harrisburg, Pa.	1.00	1.38	1.50	.65	.65	1.38	.85	1.25	1.50	1.50	1.38	1.43	1.25	1.38	1.13	1.50	1.75	.85	.85	1.25	1.25	1.00	1.00	70	1.25
Hartford, Conn.	1.13	1.25	1.65	.65	.65	1.25	.75	1.25	1.30	1.50	1.25	1.25	1.25	1.50	1.25	1.50	1.50	1.13	1.25	1.20	1.38	1.38	1.00	68	1.25
Helena, Mont.	1.13	1.50	1.50	.75	.75	1.25	1.00	1.50	1.25	1.50	1.50	1.50	1.50	1.50	1.38	1.00	1.50	1.13	1.13	1.38	1.38	1.25	1.00	95	1.25
Houston, Tex.	1.25	1.50	1.38	.40	.40	1.50	.50	1.50	1.13	1.38	1.38	1.38	1.25	1.50	1.50	....	1.38	1.13	1.13	1.50	1.50	1.50	1.50	50	1.50
Indianapolis, Ind.	1.25	1.60	1.55	.70	.70	1.60	1.27	1.58	1.30	1.45	1.37	1.50	1.25	1.45	1.50	1.45	1.45	1.25	1.25	1.50	1.50	1.15	1.00	88	1.34
Jackson, Miss.	1.00	1.50	1.50	.40	.40	1.50	.60	1.25	1.00	1.00	1.25	1.25	1.25	1.25	1.25	1.00	1.00	.90	.90	1.25	1.25	1.00	.88	40	.88
Jacksonville, Fla.	.75	.75	1.00	.30	.30	1.00	.50	.90	.75	.75	1.00	1.00	.75	.60	1.38	.75	.75	.75	.75	1.25	1.25	.90	....	40	.90
Jamestown, N. Y.	1.50	1.50	1.25	.65	.65	1.50	.65	1.50	1.25	1.50	1.25	1.25	1.25	1.25	1.20	1.00	1.00	1.00	1.35	1.50	1.20	1.10	1.10	75	1.10
Jefferson City, Mo.	1.00	1.25	1.75	.50	....	1.25	.50	1.25	1.50	....	1.25	1.25	1.25	1.00	1.00	.65	2.00	1.00	1.00	1.10	1.00	1.38	1.38	75	1.50
Kansas City, Kan.	1.38	1.63	1.50	.85	.45	1.38	.90	1.58	1.38	1.50	1.25	1.25	1.38	1.50	1.38	1.25	1.50	1.38	1.50	1.50	1.50	1.25	1.38	70	1.50
Kansas City, Mo.	1.38	1.63	1.50	.85	.45	1.38	.90	1.58	1.38	1.50	1.25	1.25	1.38	1.50	1.38	1.25	1.50	1.38	1.50	1.50	1.25	1.38	70	1.50
Lexington, Ky.	1.10	1.50	1.50	.50	.50	1.38	.70	1.25	1.25	1.50	1.50	1.50	1.00	1.25	1.00	1.50	1.50	.90	1.00	1.25	1.25	.90	1.00	50	.90
Little Rock, Ark.	1.00	1.25	1.00	.50	.50	1.25	.50	1.25	....	....	....	2.00	1.00	1.25	1.00	....	1.10	.88	1.00	1.00	1.00	.65	.65	45	1.00
Los Angeles, Calif.	1.10	1.25	1.38	.63	.63	1.25	.75	1.50	1.25	1.38	1.25	1.25	1.25	1.50	1.13	1.25	1.50	1.00	1.10	1.25	1.38	1.00	1.00	88	1.13
Louisville, Ky.	1.25	1.50	1.50	.50	.50	1.50	.90	1.50	1.38	1.10	1.25	1.50	1.25	1.38	.90	1.00	1.38	1.13	1.00*	1.38	1.38	1.25	1.00	75	1.00
Macon, Ga.	1.00	1.38	1.38	.40	.40	1.38	.75	1.25	1.00	1.25	1.38	1.25	1.25	1.25	1.25	1.00	1.25	1.00	1.00	1.38	1.38	1.25	1.25	50	1.25
Madison, Wis.	1.10	1.38	1.38	.70	.70	1.38	.70	1.38	1.00	1.00	1.25	1.25	1.10	1.30	1.38	1.00	1.00	1.05	1.05	1.38	1.38	.90	.90	65	1.20
Milwaukee, Wis.	1.20	1.45	1.38	.85	.95	1.45	.95	1.38	1.35	1.35	1.30	1.38	1.30	1.38	1.30	1.65	1.65	1.13	1.20	1.35	1.35	1.35	1.00	1 25	1.20
Minneapolis, Minn.	1.25	1.38	1.50	.85	.85	1.38	.85	1.50	1.40	1.40	1.25	1.33	1.25	1.38	1.38	1.20	1.50	1.25	1.00	1.38	1.38	1.20	1.20	85	1.25
Mobile, Ala.	1.00	1.50	1.25	.50	.50	1.50	.50	1.25	1.13	1.38	1.50	1.50	1.25	1.00	1.25	1.38	1.38	1.10	1.10	1.25	1.25	1.25	1.25	1 00	1.00
Nashville, Tenn.	1.15	1.50	1.25	.40	.40	1.50	.50	1.50	1.00	1.25	1.25	1.25	1.25	1.25	1.13	1.25	1.25	1.00	1.00	1.50	1.50	1.00	1.00	65	1.00
Newark, N. J.	1.75	1.85	2.00	1.13	1.13	1.85	1.13	1.85	2.15	2.15	1.75	1.69	1.85	2.00	1.75	2.15	2.15	1.75	1.50	1.50	1.65	1.51	1.51	1 00	1.75
New York, N. Y.	1.75	1.90	1.93	1.03	.88	1.90	1.20	2.00	1.75	2.03	1.75	1.69	1.75	1.75	2.00	....	2.13	1.50	1.89	2.00	2.00	1.86	1.60	....	1.85
Ogden, Utah	1.13	1.38	1.25	.75	.65	1.38	.90	1.50	1.13	1.13	....	1.38	1.13	1.25	1.15	1.13	1.25	1.13	1.13	1.20	1.20	1.00	1.00	90	1.13
Oklahoma City, Okla.	1.25	1.50	1.50	.50	.70	1.25	.70	1.50	1.25	1.50	1.25	1.25	1.50	1.50	1.25	1.25	1.25	1.13	1.00	1.25	1.25	1.00	1.00	75	1.25
Olympia, Wash.	1.50	1.75	1.50	1.00	1.00	1.75	....	1.25	1.50	1.50	1.38	1.75	1.38	1.50	1.50	1.50	1.85	1.25	1.25	1.50	1.50	1.25	1.25	1 20	1.25
Omaha, Neb.	1.20	1.45	1.25	.55	.55	1.45	.55	1.38	1.25	1.25	1.25	1.25	1.25	1.32	1.25	.65	1.34	1.00	1.13	1.25	1.25	1.00	1.00	60	1.00
Orlando, Fla.	.88	1.00	1.00	.35	.35	1.00	.60	1.00	1.13	1.25	1.00	1.00	1.00	.88	1.00	1.00	1.00	.75	.75	1.13	1.13	1.00	.75	60	1.00
Philadelphia, Pa.	1.40	1.65	1.65	.70	.70	1.25	....	1.75	1.50	1.50	1.50	1.40	1.38	1.63	1.63	....	1.63	1.18	1.30	1.44	1.44	1.50	1.10	75	1.50
Phoenix, Ariz.	1.13	1.50	1.38	.63	.63	1.25	.88	1.50	1.25	1.25	1.25	1.50	1.25	1.25	1.13	....	1.50	1.00	1.00	1.25	1.25	1.00	1.00	69	1.13
Pierre, S. Dak.	.85	1.25	1.00	.45	.50	1.00	.60	1.20	.50	....	.80	1.00	1.00	1.00	1.00	.70	1.00	.80	.80	1.00	1.00	....	....	50	1.00
Pittsburgh, Pa.	1.50	1.75	1.50	.80	.65	1.63	1.13	1.75	1.50	1.56	1.50	1.50	1.50	1.75	1.65	1.40	1.56	1.50	1.40	1.50	1.68	1.50	1.50	75	1.50
Portland, Me.	.80	1.25	1.25	.50	.50	1.25	.70	1.25	1.25	1.50	1.25	1.25	1.25	1.20	1.20	1.38	1.38	.75	.75	1.25	1.25	1.00	1.25	60	1.00
Portland, Ore.	1.13	1.50	1.38	.75	.63	1.50	1.13	1.50	1.00	1.25	1.25	1.25	1.13	1.38	1.38	1.50	1.50	1.10	1.10	1.50	1.50	1.38	1.33	1.00	1.25
Providence, R. I.	1.18	1.50	1.50	.60	.50	1.50	.70	1.50	1.50	1.50	1.50	1.50	1.15	1.50	1.25	1.35	1.50	1.00	1.00	1.35	1.38	1.25	....	.70	1.25
Raleigh, N. C.	1.00	1.10	1.10	.30	.35	1.10	.75	1.10	.80	.80	1.50	1.50	.75	....	1.00	.80	.80	.75	....	1.10	1.10	1.00	....	30	1.00
Reno, Nev.	1.25	1.75	1.60	.63	.63	1.75	....	1.75	....	....	....	1.75	1.00	1.75	1.50	1.00	1.50	1.50	1.31	1.50	1.50	1.38	....	1 00	1.25
Richmond, Va.	1.00	1.50	1.50	.40	.50	1.50	.65	1.25	1.25	1.50	1.38	1.00	1.25	1.38	1.00	1.50	1.25	.80	.80	1.00	1.00	1.00	.50	50	1.00
St. Louis, Mo.	1.50	1.50	1.75	.88	.88	1.25	1.00	1.75	1.50	2.00	1.30	1.50	1.58	1.75	1.50	1.50	2.00	1.50	1.63	1.63	1.63	1.75	1.58	1.00	1.50
Salt Lake City, Utah	1.13	1.38	1.25	.75	.65	1.38	.90	1.50	1.13	1.13	....	1.38	1.13	1.25	1.15	1.13	1.25	1.13	1.13	1.20	1.26	1.13	....	90	1.13
San Antonio, Tex.	1.13	1.50	1.50	.50	.40	1.50	.50	1.50	1.25	1.25	1.50	1.50	1.50	1.50	1.25	1.00	1.25	1.00	1.00	1.50	1.50	1.00	1.50	50	1.25
San Diego, Calif.	1.00	1.50	1.38	.63	.63	1.50	.88	1.50	1.38	1.38	1.25	1.25	1.25	1.50	1.25	....	1.50	1.00	1.00	1.25	1.25	.88	....	75	1.13
San Francisco, Calif.	1.25	1.75	1.60	.81	.81	1.50	1.25	1.60	1.25	1.38	1.00	1.38	1.25	1.60	1.38	....	2.00	1.25	1.21	1.40	1.38	1.21	1.21	....	1.25
Santa Fe, N. M.	1.13	1.50	1.50	.40	.55	1.50	.85	1.50	1.00	1.00	1.25	1.25	1.13	1.25	1.13	1.25	1.25	1.00	1.00	1.25	1.25	1.00	1.00	75	1.25
Seattle, Wash.	1.25	1.60	1.50	.90	1.00	1.60	1.15	1.60	1.50	1.50	1.35	1.35	1.25	1.50	1.50	1.50	1.85	1.25	1.20	1.50	1.50	1.25	1.25	1.20	1.38
Springfield, Ill.	1.38	1.63	1.50	.85	.85	1.63	1.00	1.75	1.35	1.50	1.50	1.50	1.25	1.50	1.40	....	1.65	1.25	1.25	1.50	1.50	1.30	1.30	80	1.40
Springfield, Mass.	1.25	1.63	1.50	.63	†	1.63	1.00	1.63	1.25	1.25	1.63	1.63	1.63	1.50	1.38	1.00	1.50	1.13	1.25	1.38	1.38	1.38	1.38	71	1.38
Syracuse, N. Y.	1.13	1.50	1.38	.68	.68	1.50	.68	1.50	1.25	1.38	1.38	1.38	1.13	1.50	1.50	1.38	1.38	1.25	1.10	1.50	1.50	1.00	.75	70	1.25
Toledo, Ohio	1.38	1.63	1.63	.75	.75	1.63	.75	1.65	1.50	1.50	1.50	1.50	1.63	1.63	1.65	1.50	1.50	1.40	1.13	1.50	1.50	1.25	1.63	75	1.25
Topeka, Kan.	1.00	1.38	1.40	.45	.45	1.13	.45	1.13	.85	.85	1.00	1.00	1.25	1.00	1.00	.85	.85	1.00	1.00	1.25	1.25	.85	.85	50	1.00
Trenton, N. J.	1.38	1.50	2.00	.80	.80	1.50	.80	1.50	2.00	2.00	1.50	1.50	1.50	1.50	1.87	....	2.00	1.25	1.25	1.50	1.50	1.38	1.38	75	1.38
Tucson, Ariz.	1.15	1.50	1.38	.75	.63	1.25	.83	1.50	1.25	1.50	1.25	1.50	1.25	1.13	1.13	1.13	1.50	1.00	1.00	1.25	1.25	1.00	.88	1.00	1.13
Washington, D. C.	1.63	1.75	2.00	.80	.80	1.75	.80	2.00	1.75	1.75	1.75	1.75	1.50	1.63	1.80	....	....	1.57	1.50	1.65	1.75	1.45	1.45	85	1.50
Waterloo, Iowa	1.13	1.50	1.30	.65	.65	1.50	.65	1.50	1.15	1.15	1.50	1.50	1.10	1.38	1.13	1.25	1.25	.95	1.50	1.30	1.30	1.00	1.00	1 00	1.60
Wilmington, Del.	1.25	1.50	1.65	.90	.90	1.50	.90	1.38	1.50	1.65	1.25	1.25	1.25	1.38	1.13	1.50	1.50	1.10	1.25	1.25	1.25	1.10	1.25	65	1.25

* On strike for higher wages. † Negotiating new contracts.





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Yearly Average WAGES OF SIX BUILDING TRADES in Seven Cities

Bricklayers

	Boston	New York	Chicago	Birmingham	St. Louis	San Francisco	Seattle
1913	$0.65	$0.70	$0.75	$0.70	$0.70	$0.875	$0.75
1914	.65	.75	.75	.70	.75	.875	.75
1915	.65	.75	.75	.70	.75	.875	.75
1916	.65	.75	.75	.70	.75	.875	.75
1917	.70	.75	.75	.70	.75	.875	.81
1918	.80	.81	.75	.875	.85	1.00	1.00
1919	.80	.875	.875	.875	1.00	1.125	1.125
1920	1.00	1.25	1.25	1.00	1.25	1.25	1.25
1921	1.00	1.25	1.25	1.00	1.25	1.25	1.125
1922	1.00	1.25	1.10	1.00	1.25	1.25	1.125
1923	1.25	1.50	1.10	1.125	1.50	1.375	1.25
1924	1.25	1.50	1.35	1.125	1.75	1.25	1.25
1925	1.25	1.50	1.50	1.25	1.75	1.25	1.35
1926	1.35	1.645	1.56	1.25	1.75	1.25	1.375
1927	1.40	1.75	1.625	1.25	1.75	1.375	1.375
1928	1.42	1.75	1.625	1.45	1.75	1.375	1.4275
1929	1.50	1.84	1.65	1.50	1.75	1.375	1.50
1930	1.50	1.925	1.70	1.50	1.75	1.375	1.50
1931	1.50	1.7125	1.70	.8125	1.75	1.375	1.1875
1932	1.105	1.47	1.40	.825	1.50	1.175	.975
1933	1.10	1.575	1.406	.812	1.50	1.125	1.01
1934	1.12	1.53	1.50	1.00	1.50	1.50	1.30
1935	1.20	1.50	1.50	1.00	1.50	1.50	1.00
1936	1.28	1.50	1.50	1.00	1.50	1.50	1.00
1937	1.50	1.725	1.62	1.33	1.50	1.60	1.54
1938	1.50	1.886	1.70	1.50	1.50	1.75	1.60
1939	1.50	1.893	1.70	1.50	1.50	1.75	1.60

Hodcarriers

	Boston	New York	Chicago	Birmingham	St. Louis	San Francisco	Seattle
1913	$0.35	$0.375	$0.40	.....	$0.4875	$0.50	
1914	.35	.375	.40	.....	.4875	.50	
1915	.35	.375	.40	.....	.4875	.50	
1916	.35	.375	.425	.....	.4875	.50	
1917	.40	.425	.45	.....	.4875	.50	
1918	.425	.47	.50	.....	.51	.625	
1919	.50	.575	.575	.....	.6375	.75	
1920	.70	.775	1.00	.....	.70	.93	
1921	.70	.875	1.00	.....	.85	1.00	$0.875
1922	.70	.875	.725	.....	.85	.71	.875
1923	.70	.95	.725	.....	1.00	.77	.93
1924	.82	1.00	.725	$0.385	1.20	.8125	.95
1925	.7625	1.00	.825	.6075	1.20	.8125	1.00
1926	.77	1.07	.88	.625	1.20	.8125	1.00
1927	.79	1.125	.925	.625	1.20	.875	1.00
1928	.805	1.125	.93125	.52	1.20	.875	1.00
1929	.85	1.15	.93	.50	1.20	.875	1.00
1930	.85	1.03125	.975	.50	1.20	.875	1.00
1931	.85	1.025	.975	.35	.875	.875	.70
1932	.70	1.00	.825	.40	1.00	.70	.80
1933	.70	.91	.....	.....	1.00	.70	.80
1934	.70	.825	.825	.....	.875	.70	1.00
1935	.70	.825	.825	.....	.875	.70	1.00
1936	.77	.825	.95	.30-.40	.875	1.00	1.00
1937	.85	1.14	1.025	.40	1.00	1.10	1.15
1938	.85	1.14	1.025	.40	1.00	1.25	1.15
1939	.85	1.14	1.025	.40	1.00	1.25	1.15

Carpenters

	Boston	New York	Chicago	Birmingham	St. Louis	San Francisco	Seattle
1913	$0.50	$0.625	$0.65	$0.525	$0.625	$0.625	$0.56
1914	.55	.625	.65	.45	.625	.625	.56
1915	.55	.625	.65	.45	.625	.625	.56
1916	.57	.625	.70	.45	.625	.625	.56
1917	.60	.69	.70	.45	.65	.68	.65
1918	.65	.69	.70	.55	.70	.75	.825
1919	.75	.75	.80	.65	.825	.875	.93
1920	1.00	1.125	1.25	.75	1.00	1.06	1.00
1921	1.00	1.125	1.25	.75	1.25	1.125	.875
1922	1.00	1.125	1.10	.75	1.10	1.04	.875
1923	1.05	1.125	1.25	.75	1.25	1.04	1.00
1924	1.05	1.3125	1.17	.76	1.525	1.00	1.00
1925	1.0875	1.3125	1.3475	.6025	1.50	1.00	1.0825
1926	1.20	1.45	1.39	.6575	1.50	1.00	1.125
1927	1.25	1.50	1.30	.95	1.50	1.125	1.125
1928	1.279	1.50	1.50	1.00	1.50	1.125	1.125
1929	1.38	1.55	1.47	1.00	1.50	1.125	1.125
1930	1.375	1.65	1.625	1.00	1.50	1.125	1.125
1931	1.175	1.45	1.625	.60	1.50	1.125	.875
1932	1.04	1.33	1.40	.60	1.275	.96	.695
1933	1.065	1.375	1.3125	.60	1.25	.90	.73
1934	.9375	1.40	1.3125	1.90	1.25	1.05	.83
1935	.9275	1.40	1.3156	1.00	1.25	1.10	1.00
1936	.937	1.40	1.50	.88	1.25	1.12	1.00
1937	1.14	1.60	1.57	1.06	1.35	1.31	1.23
1938	1.343	1.75	1.625	1.125	1.25	1.25	1.25
1939	1.375	1.75	1.625	1.125	1.25	1.25	1.25

Plasterers

	Boston	New York	Chicago	Birmingham	St. Louis	San Francisco	Seattle
1913	$0.65	$0.69	$0.75	.....	$0.75	$0.875	$0.75
1914	.65	.69	.75	.....	.75	.875	.75
1915	.65	.69	.75	.....	.75	.875	.75
1916	.70	.75	.75	.....	.75	.875	.75
1917	.70	.75	.75	.....	.75	.875	.875
1918	.70	.75	.81	.....	.875	1.00	1.00
1919	.80	.90	.875	.....	1.00	1.125	1.125
1920	1.00	1.25	1.25	.....	1.25	1.25	1.25
1921	1.25	1.25	1.25	.....	1.375	1.375	1.25
1922	1.125	1.25	1.10	.....	1.375	1.275	1.125
1923	1.125	1.25	1.50	.....	1.50	1.275	1.25
1924	1.25	1.50	1.50	.....	1.75	1.275	1.375
1925	1.25	1.50	1.50	.....	1.75	1.50	1.375
1926	1.50	1.75	1.50	.....	1.75	1.50	1.375
1927	1.50	1.75	1.625	.....	1.75	1.50	1.375
1928	1.50	1.75	1.625	.....	1.75	1.50	1.50
1929	1.50	1.75	1.625	.....	1.75	1.375	1.50
1930	1.625	1.925	1.70	.....	1.75	1.375	1.50
1931	1.50	1.7125	1.70	$1.00	1.75	1.375	1.1875
1932	1.625	1.50	1.375	1.25	1.50	1.10	1.20
1933	1.375	1.50	1.375	.....	1.50	1.10	1.20
1934	1.231	1.50	1.50	1.00	1.50	1.38	1.18
1935	1.375	1.50	1.50	1.00	1.50	1.25	1.375
1936	1.375	1.50	1.50	1.00	1.50	1.35	1.25
1937	1.625	1.80	1.62	1.00	1.51	1.51	1.54
1938	1.625	2.00	1.70	1.00	1.58	1.65	1.60
1939	1.625	2.00	1.70	1.00	1.58	1.60	1.60

Structural Ironworkers

	Boston	New York	Chicago	Birmingham	St. Louis	San Francisco	Seattle
1913	$0.625	$0.625	$0.68	$0.625	$0.65	$0.75	$0.625
1914	.625	.625	.68	.625	.65	.75	.625
1915	.625	.625	.68	.625	.65	.75	.625
1916	.625	.66	.68	.625	.675	.75	.625
1917	.68	.68	.69	.625	.70	.75	.75
1918	.80	.80	.70	.75	.80	.875	.875
1919	.80	.875	.875	.80	.925	1.00	1.00
1920	1.00	1.125	1.25	1.00	1.25	1.125	1.125
1921	1.00	1.125	1.25	.....	1.25	1.25	1.125
1922	1.00	1.125	1.05	.....	1.06	1.125	1.00
1923	1.05	1.125	1.05	1.05	1.25	1.125	1.125
1924	1.16	1.29	1.25	1.00	1.45	1.125	1.125
1925	1.1375	1.4675	1.36	1.135	1.50	1.125	1.125
1926	1.23	1.60	1.405	1.25	1.50	1.125	1.125
1927	1.25	1.75	1.50	1.55	1.50	1.375	1.155
1928	1.3125	1.75	1.50	1.75	1.50	1.375	1.215
1929	1.375	1.81	1.57	1.63	1.57	1.375	1.25
1930	1.375	1.925	1.625	1.25	1.75	1.375	1.25
1931	1.375	1.925	1.625	.75	1.75	1.375	1.1875
1932	1.205	1.675	1.375	.75	1.50	1.13	1.13
1933	1.14	1.65	1.35	.75	1.47	1.20	1.10
1934	1.20	1.62	1.35	1.00	1.47	1.375	1.13
1935	1.20	1.65	1.35	1.125	1.47	1.375	1.23
1936	1.20	1.58	1.50	1.10	1.47	1.375	1.25
1937	1.375	1.79	1.58	1.25	1.73	1.44	1.39
1938	1.479	1.925	1.70	1.25	1.75	1.50	1.50
1939	1.60	1.925	1.70	1.25	1.75	1.50	1.50

Common Laborers

	Boston	New York	Chicago	Birmingham	St. Louis	San Francisco	Seattle
1913	$0.35	$0.225	$0.40	.....	$0.25	$0.27	$0.375
1914	.35	.225	.40	.....	.25	.31	.375
1915	.35	.25	.40	.....	.25	.31	.375
1916	.35	.25	.425	.....	.25	.31	.375
1917	.375	.30	.45	.....	.30	.375	.4375
1918	.40	.405	.50	.....	.365	.43	.56
1919	.40	.405	.575	.....	.425	.625	.6875
1920	.6875	.75	1.00	.....	.6075	.75	.75
1921	.6875	.60	1.00	.....	.6075	.81	.75
1922	.6875	.60	.725	.....	.5575	.625	.625
1923	.6875	.615	.725	.....	.6075	.625	.625
1924	.6625	.6875	.8175	$0.335	.70	.525	.625
1925	.6025	.6525	.8175	.31	.6525	.525	.5625
1926	.615	.815	.86	.30	.6525	.525	.5675
1927	.595	.90625	.8875	.325	.5875	.55	.64
1928	.6025	.90625	.90	.325	.60	.55	.678
1929	.625	.985	.92	.29	.61	.57	.70
1930	.625	1.03125	.975	.275	.6375	.6875	.70
1931	.60	.65625	.7375	.20	.6125	.59375	.60
1932	.575	.645	.665	.225	.56	.56	.485
1933	.548	.725	.784	.248	.6223	.64	.48
1934	.55	.8475	.825	.30	.7875	.64	.53
1935	.575	.68	.825	.30	.7875	.625	.60
1936	.581	.65	.95	.35	.7875	.651	.60
1937	.725	.91	.99	.35	.86	.75	.87
1938	.735	.912	1.025	.35	.663	.65	1.00
1939	.725	.912	1.025	.35	.663	.65	.909

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Roadbuilding Costs

THIRD quarter highway costs were higher than during any other part of the year 1939 if measurement is made by the index of average bid prices on federal aid projects prepared by the construction division of the U. S. Public Roads Administration. In that quarter costs were 1.4 per cent over what they were at the beginning of the year and 1.1 per cent over the year-end figure. Taking the year as a whole roadbuilding costs rose ever so slightly.

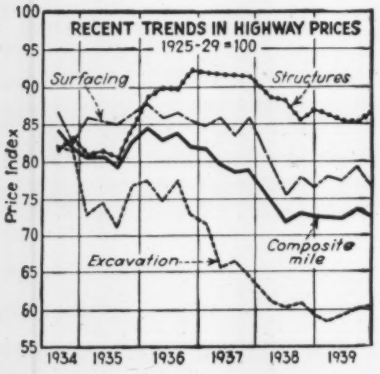
The PRA index is based on average prices for the 1925-1929 period for a so-called composite mile of road, in which "composite" are included excavation, surfacing and structures. For comparative purposes quantities are considered constant although, in actual practice, quantities are constantly increasing. The base quantities and prices for construction of the composite standard mile are given at the head of the accompanying table.

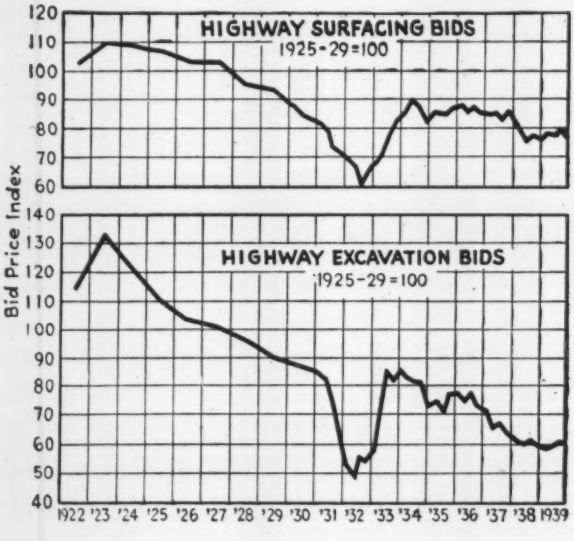
The year witnessed the arrest of the downward trend in all components of the index that has existed since 1936. As compared with bid prices that existed in the 1925-29 period, excavation has leveled off at a 60 per cent figure, surfacing at 77 per cent, structures at 86 or 87 per cent and the composite mile at somewhat over 72 per cent of the base period index figure.

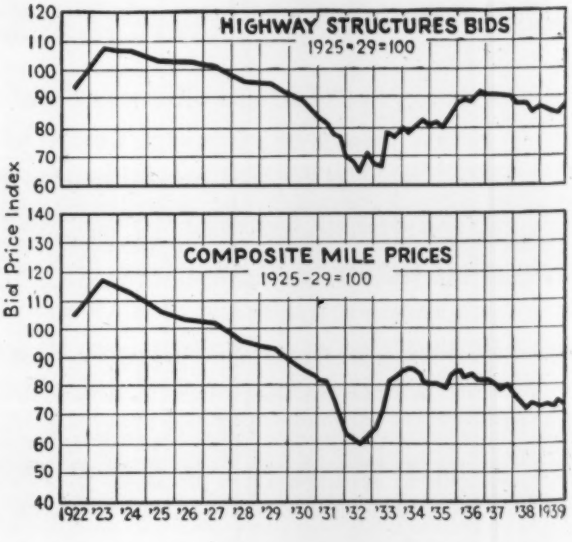
PRICE TREND IN HIGHWAY CONSTRUCTION FOR COMPOSITE STANDARD MILE

Year	Excavation [1] (17,491* cubic yards)		Surfacing [2] (3,726* square yards)		Structures				Composite mile
					Reinforcing steel (16,000* pounds)	Structural steel (4,325* pounds)	Structural concrete (68* cubic yards)	Combined	
	Bid price [3]	Sub-index	Bid price [3]	Sub-index	Bid price [3]	Bid price [3]	Bid price [3]	Sub-index	Index
Base period, 1925 to 1929	$0.35†	100.0	$2.22†	100.0	$0.052†	$0.067†	$22.15†	100.0	100.0
1922	.40	114.5	2.28	102.7	.050	.074	20.18	95.1	105.8
1923	.47	133.3	2.43	109.5	.057	.078	23.37	108.6	117.9
1924	.43	122.2	2.40	108.3	.057	.077	22.91	107.2	113.1
1925	.39	110.0	2.36	106.4	.056	.067	22.53	103.9	107.3
1926	.36	103.7	2.29	103.1	.053	.074	22.76	103.7	103.4
1927	.35	100.3	2.29	103.3	.051	.071	22.65	101.5	101.9
1928	.34	96.0	2.10	94.5	.049	.067	21.22	96.1	95.3
1929	.32	90.0	2.05	92.7	.048	.059	21.58	95.0	92.1
1930	.30	86.3	1.86	84.1	.045	.061	20.08	89.4	85.7
1931	.27	77.2	1.68	75.6	.040	.054	18.02	79.9	76.8
1932	.18	52.3	1.45	65.2	.034	.046	15.32	68.0	61.0
1933	.26	73.6	1.67	75.1	.037	.046	16.15	72.1	74.1
1934									
1st Q.	.30	85.5	1.90	85.7	.042	.049	17.82	79.9	84.7
2nd Q.	.29	82.6	1.98	89.3	.042	.051	17.31	79.1	85.3
3rd Q.	.29	81.7	1.92	86.7	.042	.053	17.98	81.3	84.0
4th Q.	.29	81.3	1.82	82.1	.044	.057	17.81	82.7	81.9
1935									
1st Q.	.25	72.7	1.90	85.8	.044	.051	17.62	80.7	80.3
2nd Q.	.26	74.1	1.89	85.1	.044	.052	17.51	81.1	80.5
3rd Q.	.25	70.9	1.88	84.8	.044	.052	17.22	80.2	79.1
4th Q.	.27	76.9	1.91	86.2	.044	.053	18.77	84.1	82.5
1936									
1st Q.	.27	77.2	1.94	87.7	.044	.056	20.28	88.7	84.1
2nd Q.	.26	74.4	1.90	85.8	.046	.059	20.06	89.7	82.3
3rd Q.	.27	77.2	1.91	86.3	.046	.061	19.87	89.5	83.5
4th Q.	.25	72.7	1.89	85.3	.046	.062	20.87	92.0	81.8
1937									
1st Q.	.25	71.2	1.88	84.8	.047	.063	20.31	91.7	81.0
2nd Q.	.23	65.5	1.90	85.8	.049	.067	19.42	91.3	79.3
3rd Q.	.23	66.1	1.85	83.4	.049	.067	19.42	91.5	78.1
4th Q.	.22	63.8	1.91	85.9	.048	.065	19.90	91.3	78.8
1938									
1st Q.	.21	61.0	1.77	79.8	.046	.065	19.13	88.6	74.4
2nd Q.	.21	60.1	1.67	75.2	.046	.064	19.10	88.2	71.8
3rd Q.	.21	60.7	1.73	77.8	.044	.061	18.73	85.4	72.8
4th Q.	.21	59.8	1.70	76.7	.044	.060	19.29	86.7	72.2
1939									
1st Q.	.21	58.7	1.73	78.0	.043	.058	19.46	86.4	72.3
2nd Q.	.21	59.3	1.72	77.4	.043	.059	19.03	85.4	72.1
3rd Q.	.21	60.1	1.76	79.4	.043	.060	18.95	85.1	73.3
4th Q.	.21	60.4	1.71	76.9	.045	.060	19.07	86.8	72.5

[1] Common excavation plus other excavation items expressed as equivalent common excavation.
[2] Portland-cement concrete plus other surfacing items expressed as equivalent portland-cement concrete.
[3] Indexes and totals were calculated with the bid prices carried to 1 more decimal place than that to which they are shown in this table.
Column showing amount of bid price times fixed quantity omitted in this table.
* Fixed quantities used for establishing composite mile for price trend.
† Fixed prices used for establishing composite mile index base.







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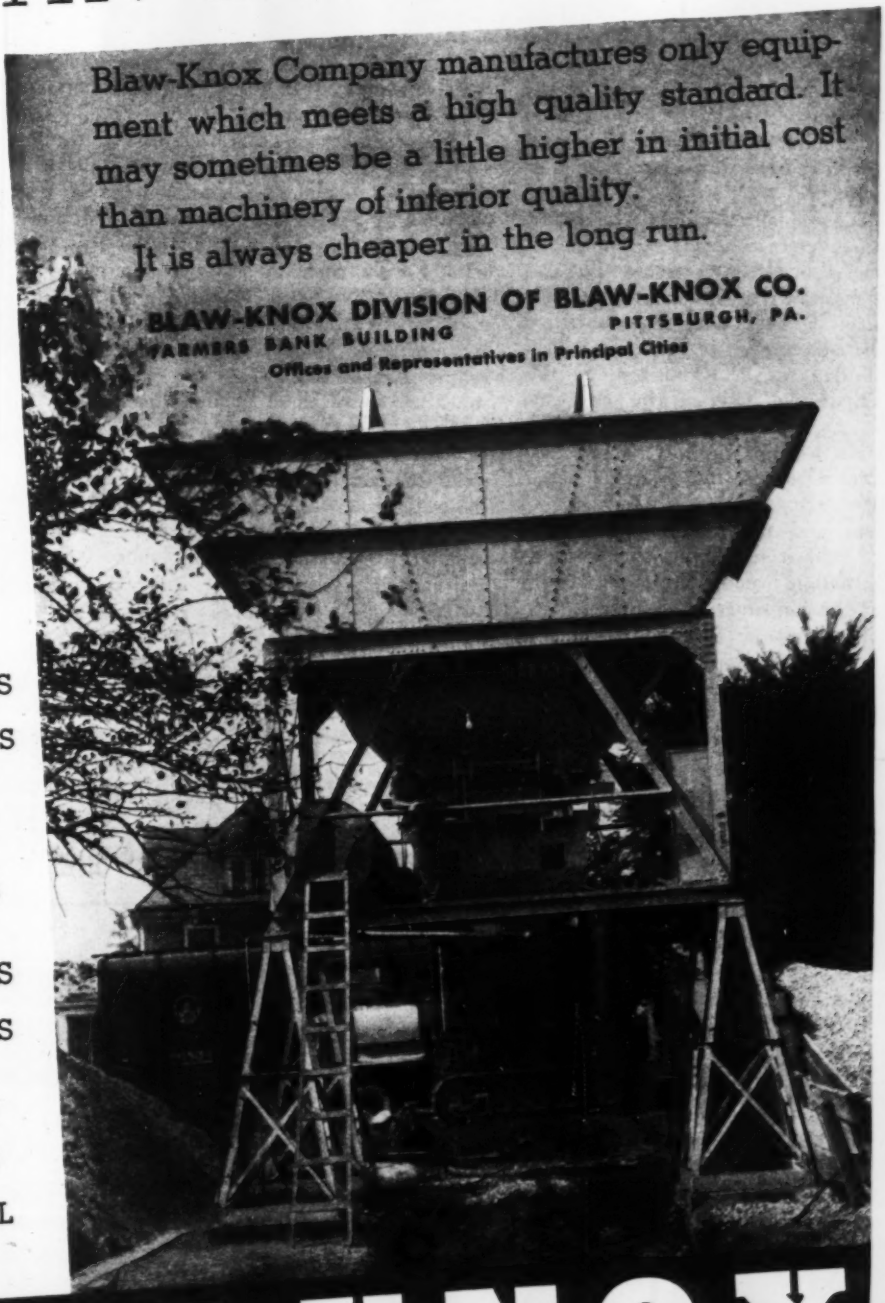

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CONSTRUCTION EQUIPMENT

Contractors Defeat Cost Rise

IN THE FACE of rising labor and material costs contractors have held down the unit prices bid for excavation and concrete on state highway work from 27 to as much as 64 per cent below the labor and material cost trend measured by the *Engineering News-Record* Construction Cost Index.

Theoretically this should be so. Machines and management could not otherwise justify themselves. But how to measure the effect is a problem in an industry such as construction where every job is handled under a different set of conditions. In this comparative study of bid prices and the *Engineering News-Record* Cost Index, state highway work was selected because the class A concrete for structures, the concrete for pavement and the excavation involved are subject to similar specifications the nation over and to continuity of engineering supervision in each state, both conditions that contribute to a sound comparison of price trends.

Measurement of the trend of material and labor cost is afforded by the *Engineering News-Record* Construction Cost Index. The extent to which price trends can hold below this index is in large measure a result of efficient equipment use and management, although competitive conditions, shaved profits and possibly some unbalanced bidding are also price depressing factors.

The accompanying tables report the average low bids submitted by contractors to state highway departments, compiled by the respective state highway engineers. By using 1926 = 100 as a base for each state, the median price trend has been computed and plotted for each class of work in the accompanying charts; half of each year's relative bid prices for each state are above these median lines, half are below.

The median (adopted because weighted averages were impractical) shows the following relative position of contractor unit price averages for low bids compared with the labor and material cost trend.

	Price Trend		
	1926	1935	1939
ENR Construction Cost Index	100	94.4	113.0
Common Excavation—Median	100	63.5	48.0
Unclassified Excavation—Median	100	76.5	57.0
Rock Excavation—Median	100	62.0	41.0
Structure Concrete—Median	100	83.3	83.0
Pavement Concrete—Median	100	76.0	73.0

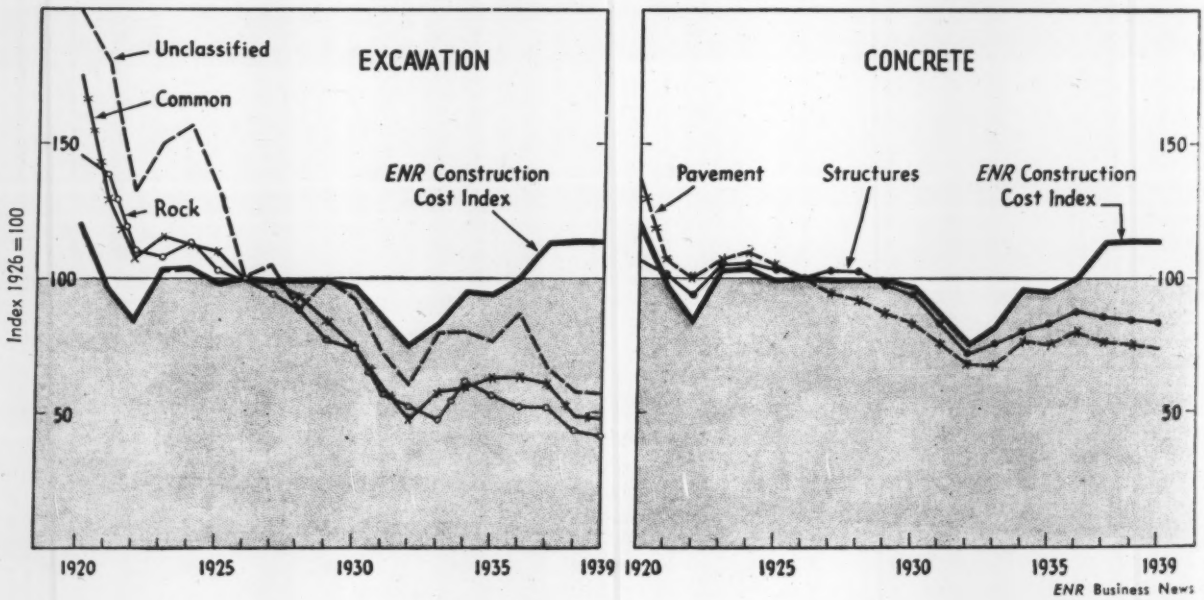
Note how the pavement concrete price trend pulls down below the structure concrete price. Surely pavement concrete represents the highest degree to which organized production methods and coordinated equipment operation have been applied to construction work.

Note how the excavation price trend has dipped in the past two years. Here, too, is a reflection of mechanized production methods. The lowest unit price average for all grading contracts comes from Iowa, 9.845 c. per cu. yd. A check on the accuracy of this figure brings the following from Mr. Coykendall, Engineer of Estimates and Contracts:

"Grading work in connection with our paving projects is now let as a separate contract to grading contractors. . . . You might be interested to know that on May 28, 1940 a contract was awarded on approximately one-half million yards of grading in connection with a paving project at a unit price of 7¢ per cubic yard. This, of course, is earth excavation, and overhaul is paid for average haul exceeding 1,000 feet."

Grateful acknowledgment is made to state highway engineers for their cooperation in supplying data for this test study of the effect of technique on prices. Credit for the longest price series goes to Virginia with prices back to 1909. California's price records go back to 1913 and Delaware's to 1914. The records collectively speak eloquently of the efficiency of contractors handling state highway work.

TREND OF AVERAGE UNIT PRICES BID BY CONTRACTORS ON STATE HIGHWAY WORK



Average Unit Prices Bid by Contractors on State Highway Work

EXCAVATION, EARTH OR COMMON—DOLLARS PER CUBIC YARD

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Ark.	....	....	....	....	....	$0.25	$0.25	$0.29	$0.28	$0.28	$0.24	$0.20	$0.26	$0.21	$0.20	$0.26	$0.16	$0.20	$0.19	$0.20
Colo.	....	$0.44	$0.31	$0.33	$0.40	0.34	0.30	0.38	0.32	0.26	0.19	Changed to unclassified								
Conn.	$1.15	1.40	1.10	0.75	1.10	1.25	1.10	1.00	0.90	0.85	0.75	0.50	0.38	0.40	0.35	0.45	0.55	0.45	0.55	0.50
Del.	1.53	1.18	0.88	1.32	1.37	1.09	0.94	0.92	0.82	0.83	0.68	0.56[1]	0.34[1]	0.31[1]	1.04[1]	0.40[2]	0.63	0.60	0.41	0.41
Del.	....	....	....	....	....	....	....	....	....	....	....	0.84[3]	0.77[3]	0.74[3]	0.99[2]	0.73[2]	....	....	....	....
Ill.	0.92	0.50	0.47	0.48	0.47	0.50	0.45	0.47	0.43	0.38	0.37	0.26	0.31	0.30	0.31	0.38	0.44	0.35	0.31	0.37
Iowa[4]	....	....	0.25	0.26	0.23	0.22	0.23	0.26	0.21	0.19	0.18	0.15	0.12	0.13	0.14	0.16	Same as pavement grading			
Iowa[4]	....	....	0.57	0.66	0.73	0.68	0.46	0.47	0.39	0.32	0.34	0.28	0.16	0.17	0.22	0.18	0.18	0.15	0.12	0.10
Kans.	....	....	....	....	....	....	0.37	0.37	0.24	0.24	0.23	0.21	0.18	0.14	Changed to unclassified					
Me.	....	....	....	1.55	1.26	1.19	1.15	1.13	1.09	0.88	0.78	0.53	0.42	0.65	0.73	0.73	0.58	0.59	0.43	0.36
Mass.	....	....	....	....	1.26	1.07	0.90	0.77	0.71	0.63	0.50	0.32	0.20	0.36	0.38	0.32	0.33	0.55	0.25	0.34
Mich.[5]	1.01	0.82	0.52	0.65	0.54	0.46	0.49	0.48	0.45	0.41	0.34	0.21	0.19	0.28	0.26	See grading only below				
Mich.[7]	0.77	0.56	0.43	0.48	0.43	0.50	0.44	0.40	0.45	0.39	0.34	0.24	0.19	0.21	0.22	0.31[5]	0.43[5]	0.34[5]	0.25[5]	0.20[5]
Mo.	0.65	0.47	0.37	0.42	0.37	0.39	0.36	0.37	0.34	0.37	0.35	0.24	0.22	0.19	0.25	0.23	0.28	0.23	0.16	0.23
Nebr.	0.45	....	0.31	....	0.23	....	0.20	....	0.19	....	0.19	0.16	0.14	0.17	0.16	0.17	0.18	0.16	0.14	0.12
N. H.	....	1.55	1.16	1.81	1.40	....	1.36	1.20	1.08	0.90	0.63	0.40	0.37	0.57	0.58	0.46	0.58	0.65	0.44	0.37
N. J.	....	....	....	....	1.38	1.21	0.96	0.82	0.72	0.56	0.52	0.33	0.24	0.29	0.34	0.37	0.30	0.32	0.28	0.33
N. Dak.	....	....	....	....	....	....	0.30	0.31	....	0.25	....	0.17	0.14	....	0.17	0.14	0.13	0.11	0.14	0.15
Ore.	0.50	0.66	0.39	0.41	0.40	0.31	0.36	0.36	0.34	0.30	0.29	0.25	0.27	0.27	0.28	0.24	0.21	0.20	0.17	0.17
R. I.	1.57	1.15	1.05	1.30	1.04	0.95	0.81	0.71	0.53	0.37	0.43	0.24	0.17	0.33	0.47	0.37	0.38	0.37	0.46	0.67
S. Car.	....	0.31	0.26	0.32	0.35	0.37	0.33	0.33	0.31	0.33	0.32	0.29	0.28	0.29	0.49	0.42	0.41	0.34	0.22	0.23
S. Dak.	0.58	0.46	0.22	0.27	0.26	0.22	0.21	0.21	0.23	0.20	0.20	0.17	0.14	0.14	0.18	0.17	0.21	0.17	0.11	0.10
Tex.	....	....	....	....	....	....	0.18	0.19	....	0.20	0.18	0.13	0.15	0.19	0.18	0.17	0.26	0.18	0.17	0.20
Utah	0.92	0.80	0.80	0.42	0.42	0.35	0.59	0.49	0.61	0.56	0.20	0.33	Changed to unclassified							
Vt.	1.39	1.61	1.65	1.22	1.20	1.28	1.20	1.16	1.12	0.76	0.78	0.52	0.34	0.54	0.58	0.65	0.59	0.38	0.31	0.30
Wash.	....	0.46	0.46	0.36	0.45	0.43	0.35	0.40	0.37	0.34	0.25	0.28	0.37	0.37	0.24	0.22	0.26	0.33	0.25	0.23
Wisc.	0.72	0.70	0.46	0.54	0.50	0.45	0.41	0.46	0.46	0.37	0.33	0.27	0.21	0.21	0.23	0.25	0.27	0.23	0.24	0.21

Notes: [1]Using Machines. [2]Hand Labor. [3]Grading—No surfacing. [4]Grading for pavement. [5]Earth Excav.—all contracts. [6]Grading for Surfacing. [7]Grading only.

EXCAVATION, UNCLASSIFIED—DOLLARS PER CUBIC YARD

Calif.	$1.10	$0.94	$0.71	$0.74	$0.75	$0.59	$0.44	$0.50	$0.56	$0.45	$0.42	$0.32	$0.28	$0.23	$0.27	$0.29	$0.42	$0.36	$0.29	$0.31
Colo.	....	....	....	....	....	....	0.68	0.28	0.40	0.68	0.41	0.26	0.20	0.23	0.27	0.22	0.56	0.28	0.23	0.31
Nev.	....	....	....	....	0.75	0.73	0.43	0.45	0.29	0.35	0.37	0.33	0.27	0.37	0.46	0.51	0.39	0.27	0.22	0.23
Pa. (Roadways Cl. I)	....	....	....	1.43	1.38	1.17	0.88	0.94	0.79	0.81	0.78	0.54	0.35	0.48	0.57	0.49	0.55	0.51	0.40	....
Pa. (Structures Cl. II)	....	....	....	....	....	....	1.35	1.63	1.61	1.67	1.78	1.34	1.04	1.13	1.40	1.43	1.65	1.79	1.48	....
Utah	....	....	....	....	....	....	....	....	....	....	....	....	0.22	0.43	0.39	0.31	0.33	0.23	0.29	0.18
Va. (Roadwy)	0.70	0.70	0.47	0.47	0.50	0.50	0.47	0.45	0.46	0.52	0.43	0.34	0.28	0.44	0.49	0.41	0.39	0.33	0.30	0.28

EXCAVATION, ROCK—DOLLARS PER CUBIC YARD

Ark.	....	....	....	....	....	$1.42	$1.50	$1.27	$1.17	$1.15	$0.86	$0.82	$0.53	$0.64	$0.74	$0.68	$0.22	$0.65	$0.64	$0.36
Colo.	....	$1.48	$1.21	$1.23	$0.94	0.97	1.13	1.28	0.93	0.86	0.85	Changed to Unclassified								
Conn.	$3.00	4.25	3.00	3.00	3.00	4.00	3.75	3.75	3.00	2.50	2.35	2.00	2.00	1.50	1.25	1.50	1.15	1.29	1.50	1.50
Del.	6.00	....	2.00	4.00	3.50	4.08	3.90	6.25	15.00	....	2.00	1.08	1.75	2.38	4.15	4.00	1.75	....	2.50	5.00
Ill.	3.40	2.39	1.72	1.83	1.26	0.78	0.69	0.82	0.64	0.75	0.53	0.39	0.43	1.47	0.94	1.33	2.83	1.11	1.23	1.29
Kans.	....	....	....	....	....	....	1.60	1.50	1.50	1.25	1.25	1.00	0.94	0.59	0.73	0.60	....	....	0.40	0.31
Me.	....	....	....	3.70	4.24	4.11	4.12	3.80	3.64	3.28	2.97	2.20	2.25	2.78	3.79	3.65	2.83	2.94	2.17	2.08
Mass.	....	....	....	....	3.84	2.99	2.02	2.33	3.00	2.46	2.53	1.60	1.03	0.98	1.87	1.71	1.46	1.33	1.00	0.89
Mich.	3.43	3.50	2.56	2.30	2.69	3.26	2.36	1.01	1.51	1.85	1.74	1.30	2.45	1.36	1.66	3.01	3.10	2.04	1.79	2.08
Mo.	2.21	2.20	1.85	1.81	1.71	1.69	1.69	1.56	1.42	1.47	1.34	0.98	0.81	0.82	0.69	0.52	0.77	0.62	0.40	0.70
N. H.	....	5.45	5.20	5.41	4.80	....	4.48	3.99	3.98	3.16	2.79	2.08	2.06	1.63	1.35	1.56	2.25	2.71	0.73	1.33
N. J.	....	....	....	....	5.55	4.19	3.64	2.84	3.31	2.04	2.36	1.96	0.42	1.00	1.16	....	....	1.53	....	1.37
Ore.	1.41	1.17	0.99	1.09	0.98	0.99	0.70	0.79	0.78	0.87	0.82	0.84	0.50	0.60	0.55	0.60	0.54	0.56	0.47	0.58
R. I.	4.89	2.62	3.72	3.68	3.28	3.11	3.49	2.80	2.01	2.50	2.03	2.02	2.15	1.60	1.71	2.00	1.83	1.69	1.45	1.42
S. Dak.	....	....	....	1.08	1.18	1.02	0.97	0.97	0.90	0.79	1.12	0.84	0.75	0.47	0.78	0.76	0.76	0.80	....	....
Tex.	....	....	....	....	....	....	1.31	1.07	....	1.06	0.98	0.59	0.41	0.87	0.81	0.74	....	....	....	....
Utah	1.85	1.82	1.82	1.72	1.72	1.27	1.26	1.12	1.35	1.18	0.80	0.88	Changed to Unclassified							
Vt.	5.19	5.45	4.75	3.34	3.68	4.81	3.91	2.98	3.22	2.46	2.80	3.51	1.06	1.54	2.02	1.95	1.66	1.51	1.69	1.32
Wash.	....	1.95	1.72	1.63	1.53	1.13	1.17	1.75	0.85	1.03	1.20	0.75	0.75	0.80	0.88	0.81	0.76	0.63	0.66	0.59
Wisc.	2.10	1.87	1.56	2.30	2.01	1.53	1.77	1.74	2.14	1.35	1.28	0.81	0.47	0.36	0.38	0.46	0.62	0.32	0.33	0.29

STRUCTURE CONCRETE—INCLUDING CEMENT BUT NOT INCLUDING REINFORCING STEEL AND EXCAVATION—DOLLARS PER CUBIC YARD

Ark.	....	....	....	....	....	$21.16	$21.88	$22.34	$21.50	$20.29	$18.97	$18.61	$13.50	$17.53	$18.42	$18.50	$18.72	$18.53	$17.42	$18.26
Colo.	....	$23.01	$19.07	$19.24	$22.84	20.63	18.21	18.97	19.86	18.10	18.29	17.23	14.67	16.03	17.41	19.21	19.38	19.65	18.59	19.87
Conn.	$22.00	19.20	22.00	23.00	22.00	25.00	25.00	27.50	27.54	27.66	22.69	25.02	23.03	13.45	14.75	15.60	16.10	17.07	17.75	16.75
Ill.	31.50	22.33	17.33	20.33	21.17	20.00	18.83	20.17	20.83	19.00	19.00	16.17	14.17	16.17	17.33	21.27	28.58	25.11	22.57	23.37
Kans.	....	....	....	....	....	....	20.57	19.50	17.00	17.00	16.50	16.00	14.59	12.56	16.12	14.84	19.11	15.65	14.83	16.59
Ky.	....	....	....	....	21.26	....	19.43	20.35	20.34	....	18.62	17.23	15.01	12.93	15.08	15.32	16.48	17.90	16.55	16.92
Mass.	....	....	....	35.10	37.13	33.79	26.98	25.41	24.88	23.90	16.94	11.57	13.06	16.75	16.89	11.72	12.98	12.53	14.50	
Mich. (1:2:3½)	....	....	....	....	....	....	24.82	18.79	22.20	20.87	20.88	15.58	16.12	18.79	19.41	22.45	20.76	20.53	18.91	19.50
Mo.	30.00	29.00	27.00	21.90	18.49	16.53	17.22	18.59	18.22	17.91	17.58[1]	15.48	14.42[2]	15.00[2]	17.63[2]	18.75[2]	22.05	23.46	20.62	21.73
Nebr.	36.42	....	29.98	....	23.07	....	22.31	....	19.78	....	16.74	14.80	13.55	16.11	15.10	19.56	18.12	16.79	....	....
Nev.	....	....	....	....	42.40	35.50	32.50	35.17	40.00	35.00	35.90	28.75	21.80	24.80	25.60	28.00	27.30	28.00	27.70	24.47
N. Dak.	....	....	....	....	....	....	22.42	26.30	....	25.17	....	17.78	17.45	....	22.75	18.91	22.13	20.65	21.68	23.69
Ore.	30.91	27.45	27.18	26.83	23.60	26.30	29.39	23.91	22.78	21.34	21.32	22.25	20.85	23.21	23.19	21.35	24.47	24.61	21.75	21.75
Pa. (Bridges)	....	....	....	....	....	....	26.37	25.08	19.54	24.16	24.23	16.90	13.75	16.87	17.01	15.25	17.02	18.35	16.15	....
Pa. (Roadway Structures)	....	....	28.13	30.53	30.84	29.23	28.06	25.96	26.23	25.32	20.02	15.19	19.22	18.96	18.94	20.65	20.06	19.07	....	
R. I.	21.00	22.33	25.27	22.80	22.14	25.88	24.50	23.43	24.66	23.70	23.55	21.28	18.77	17.00	13.41	18.23	17.75	25.00	17.95	18.94
S. Car.	....	25.12	20.83	23.44	26.44	25.47	24.65	23.53	21.95	22.19	22.53	24.00	18.75	18.75	22.65	24.97	28.50	26.25	24.08	23.91
S. Dak.	30.76	33.16	22.71	23.30	24.58	24.00	21.66	23.17	21.43	22.11	20.76	18.34	16.58	16.90	18.70	19.68	22.43	20.99	18.05	18.00
Tenn.	....	....	....	....	....	....	22.00	22.50	22.44	21.16	19.70	13.50	11.25	14.75	17.50	20.00	20.00	20.75	19.11	19.01
Tex.	....	....	....	....	....	....	21.30	20.71	....	20.31	20.20	15.90	14.24	18.87	19.63	17.48	19.41	17.16	18.03	18.97
Utah	21.00[3]	16.64[3]	16.64[3]	16.75[3]	16.75[3]	20.33[3]	20.18[3]	20.46[3]	22.15[3]	24.58[3]	20.00[3]	20.12[3]	16.22[3]	21.08[4]	20.00[4]	23.32[4]	25.07[4]	23.48[4]	24.65[4]	23.00[4]
Vt.	15.00	25.36	23.57	22.20	23.96	22.09	25.75	27.69	27.22	24.07	22.83	19.28	16.00	18.11	20.21	20.33	20.67	18.98	18.98	20.49
Va.	23.00	23.00	20.00	20.00	22.55	22.00	21.34	21.87	21.68	21.50	20.70	17.50	13.50	17.00	18.50	21.25	19.22	17.75	18.50	19.00
Wash.	....	34.25	24.00	27.50	31.00	24.96	25.75	27.25	25.30	25.00	26.50	19.50	18.00	19.50	21.63	17.61	24.24	24.41	25.30	24.33
Wisc.[5]	21.80	21.00	22.10	25.40	24.60	23.65	24.32	24.30	28.00	25.38	23.97	22.58	18.92	20.96	21.45	19.82	20.90	19.34	20.00	19.50

Notes: [1]1930 Specs. Revised. [2]1932–35 inc. enforced hand labor and equip. control. [3]State buys cement. [4]Contractor buys cement. [5]Smaller structures including steel.

PAVEMENT CONCRETE—INCLUDING CEMENT BUT NOT INCLUDING REINFORCING STEEL AND EXCAVATION—DOLLARS PER CUBIC YARD

Calif.	$16.25	$17.34	$14.29	$13.18	$13.49	$10.85	$10.58	$10.74	$10.23	$10.23	$8.69	$8.42	$7.17	$5.94	$7.33	$8.00[1]	$8.52[1]	$7.71[1]	$8.00[1]	$7.58[1]
Conn.	14.00	13.61	13.00	11.52	11.60	14.32	12.74	11.93	11.40	11.03	9.78	9.59	8.70	7.20	7.59	8.20	9.80	8.48	10.05	7.95
Del.	17.54	16.88	13.25	15.07	16.01	15.03	14.30	13.30	13.11	12.05	12.45	10.65	9.96	10.02	11.23	11.40	9.84	10.31	9.12	9.22
Iowa	....	....	11.63	11.20	11.64	11.28	10.33	10.52	9.80	9.58	10.02	9.40	7.30	8.59	9.23	9.17	8.99	8.81	8.49	8.35
N. H.	....	16.12	17.79	20.90	18.15	....	18.15	15.16	14.63	13.37	11.40	9.79	7.76	10.27	12.12	10.55	12.65	13.05	12.78	10.44
N. J.[2]	....	....	....	....	14.54	14.36	14.09	12.92	12.08	11.20	11.20	9.16	7.68	8.68	9.32	9.72	8.79	9.25	9.25	9.31

DOLLARS PER SQUARE YARD

Colo.	....	....	....	$2.16	$2.36	$2.13	$2.17	$2.11	$1.97	$2.02	$1.79	$1.89	$1.31	$1.49	$1.94	$2.21	$1.74	$1.68	$1.98	$1.93
Ill.[3]	$2.38	$1.85	$1.53	1.55	1.58	1.55	1.48	1.44	1.40	1.33	1.23	1.05	0.95	....	....	....	....	....	....	....
Ill.[4]	....	....	....	....	....	....	....	1.58	1.60	1.63	1.30	1.10	1.10	1.25	1.25	1.41	1.57	1.64	1.26	1.50
Kans.	....	....	....	....	....	....	2.25	2.05	1.89	1.99	1.84	1.68	1.59	2.14	2.07	1.86	2.21	1.88[5]	1.85[5]	1.80[5]
Ky.	....	....	....	....	2.71	....	2.37	2.36	2.25	....	2.09	1.79	1.30	1.20	1.58	1.69	1.78	1.99	1.77	1.83
Mich.	....	....	....	....	2.18	1.99	2.01	1.95	2.02	1.81	1.71	1.35	1.19	1.41	1.64	1.63	1.70	1.57	1.46	1.42
Nebr.[6]	....	....	....	....	....	....	2 12	....	2.12	....	1.70	1.44	1.55	1.86	1.90	1.83	1.86	1.76	1.73	1.74
R. I.	....	....	....	2.65	2.93	2.97	2.34	2.46	2.56	2.02	2.02	1.92	1.62	1.58	1.85	1.70	1.82	1.77	1.73	1.74
So. Dak.	....	....	....	....	2.50	....	2.55	1.99	2.09	....	2.21	1.84	1.82	1.61	1.92	1.94	2.10	1.93	2.09	2.06
Tenn.	....	....	....	....	....	....	2.32	2.82	2.62	1.73	1.73	1.41	1.31	1.75	1.97	1.83	1.91	1.79	1.89	1.69
Tex.	....	....	....	....	....	....	2.34	2.14	2.04	2.04	1.94	1.61	1.18	1.46	1.55	1.56	1.70	1.45	1.43	1.44
Utah	2.37	1.44	1.23	1.40	....	....	1.35	.....	1.20	1.15	1.12	1.14	1.08	1.71	2.01	2.18	2.36	1.88	2.16	1.94
Wash.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1.84	1.88	1.95	2.10	2.23

Notes: [1]Includes dowels. [2]Mixture A 1:1¾:3½. [3]6" pavement. [4]7" pavement. [5]9"x7"x9", Water Cement Ratio used, 1929–40. [6]Include reinforcing.

BASE RATES ON COMPENSATION INSURANCE FOR CONSTRUCTION—APRIL 1, 1940[A]

Data Compiled by Herbert L. Jamison & Co., Insurance Brokers, New York, N. Y.

Classification of Work (1)	Ala.	Ariz.	Ark.(E)	Cal.	Colo.	Conn.	Del.	D. C.	Fla.	Ga.	Idaho	Ill.	Ind.	Iowa	Kans.	Ky.	La.	Me.	Md.	Mass.	Mich.	Minn.	Miss. (E)	Mo.	Mont.	Neb.
1. Boiler installation	4.06	8.43	8.97	6.21	7.30	4.61	3.30	6.88	4.25	3.65	5.98	5.55	5.26	3.99	5.72	4.54	8.72	5.49	5.51	6.02	6.66	6.48	9.35	8.98	6.61	8.59
2. Carpentry, private or 2-family residences	2.58	4.09	3.17	5.85	4.68	2.32	2.50	3.87	3.93	2.11	4.17	4.70	3.06	3.27	3.38	3.22	5.63	3.16	3.05	2.65	5.78	5.21	2.86	5.27	4.71	5.25
3. Carpentry, 3 stories or less — dwellings	2.58	4.09	3.17	5.85	P	2.32	2.50	3.87	3.93	2.11	4.17	4.70	3.06	3.27	P	3.22	5.63	3.16	3.05	P	5.78	5.21	2.86	5.27	4.71	5.25
4. Carpentry, interior trim installation	1.29	4.09	1.98	5.85	2.17	1.82	2.50	2.12	1.32	1.48	2.24	1.79	1.40	1.28	1.72	1.33	2.34	1.65	1.72	2.00	1.97	5.21	1.99	5.27	2.58	2.58
5. Carpentry, general	3.82	9.16	9.04	5.85	6.67	5.20	2.50	5.55	3.93	5.73	6.71	6.60	4.79	3.27	4.52	4.49	7.86	5.74	6.28	8.65	5.78	5.21	11.50	5.27	7.49	7.42
6. Cement wk., sidewalks, drives & cellar floors	1.63	2.59	2.53	2.05	2.72	1.98	2.40	2.50	1.66	1.62	2.34	2.36	1.78	1.65	2.19	1.68	2.97	2.11	2.16	2.56	2.32	2.57	2.61	3.08	2.77	3.26
7. Conc. const.— bridges & culv. monolithic (2)	6.69	14.26	19.95	10.23	8.94	7.45	3.65	12.76	6.01	6.57	10.70	6.23	8.22	7.33	8.18	7.19	12.39	10.36	7.62	15.66	10.59	8.76	15.87	15.27	11.85	14.99
8. Concrete construction — reinf. floors (2)	4.06	8.43	9.30	5.09	5.98	5.87	3.65	4.98	5.01	3.51	6.29	5.03	3.92	3.80	5.96	5.79	7.61	5.85	6.28	6.39	6.84	6.30	9.71	7.84	7.18	8.88
9. Conc. const.— dwgs to 3 stor.— not mono. (2)	2.29	8.43	6.57	5.09	P	3.87	3.65	4.92	2.19	1.94	3.38	3.18	2.72	1.91	P	2.17	3.75	4.25	4.63	P	3.57	1.35	6.83	5.29	3.78	4.02
10. Concrete construction, general (2)	4.06	8.43	9.30	5.09	5.98	5.87	3.65	4.98	5.01	3.51	6.29	5.03	3.92	3.80	5.96	5.79	7.61	5.85	6.28	6.39	6.84	6.30	9.71	7.84	7.18	8.88
11. Electrical equipment installation	1.88	4.59	5.61	3.26	3.34	3.02	.80	3.07	2.93	2.43	3.57	3.18	2.20	1.99	2.99	1.95	3.77	2.50	2.38	3.53	3.28	3.32	5.09	4.89	4.02	3.96
12. Electrical wiring — within buildings	1.23	2.68	2.38	2.33	2.14	1.65	.80	2.12	1.77	1.60	2.11	1.82	1.46	1.27	1.65	1.34	2.26	1.62	1.78	1.63	1.82	2.11	2.40	2.71	2.41	2.53
13. Excavation — earth (3)	3.09	7.76	5.21	6.23	6.52	4.29	2.55	5.45	3.06	2.24	6.07	4.69	3.34	3.52	4.62	3.09	5.90	4.09	4.22	5.55	4.18	4.96	5.34	9.48	6.82	7.22
14. Excavation — rock (3)	D4.30	11.98	12.16	12.75	D7.74	D6.01	2.55	D9.66	D4.52	D3.93	D6.73	D6.12	D4.85	D4.24	D5.88	D4.78	D7.85	D5.82	D5.79	D7.72	D6.77	D6.83	9.93	D8.60	D7.22	D9.07
15. Glazing	3.39	6.29	3.86	6.00	5.89	4.40	1.35	5.62	3.54	3.51	5.61	4.38	3.75	3.39	4.59	3.62	6.19	4.49	4.47	3.51	5.29	5.48	3.71	6.22	6.30	6.97
16. Lathing	1.68	4.06	2.44	5.39	2.90	2.40	1.10	2.80	1.72	1.92	3.05	2.43	1.84	1.66	2.28	1.80	3.12	2.22	2.27	3.14	2.65	2.75	2.46	3.30	3.40	3.44
17. Masonry, brick, stone or conc. block	2.29	6.36	6.57	3.78	4.01	3.87	2.10	4.92	2.19	1.94	3.38	3.18	2.72	1.91	2.95	2.17	3.75	4.25	4.63	6.32	3.57	1.35	6.83	5.29	3.78	4.02
18. Office workers	.07	.09	.09	.08	.09	.08	.05	.09	.07	.06	.08	.07	.07	.07	.07	.07	.08	.08	.13	.07	.07	.08	.08	.07	.09	.10
19. Painting and decorating	2.41	4.54	3.98	4.79	4.52	2.81	1.85	4.15	2.90	2.21	4.62	3.13	3.28	3.00	3.50	2.89	4.65	3.37	3.64	M11.02	4.17	3.94	3.21	3.93	5.04	5.41
20. Painting steel structures & bridges	12.00	33.67	30.61	17.30	21.58	14.78	6.90	19.96	10.30	11.04	21.40	13.58	11.66	10.48	15.82	12.75	16.80	15.91	16.43	21.93	19.76	18.33	22.39	34.21	22.27	25.22
21. Plastering	2.10	4.06	2.44	5.39	3.67	2.85	1.10	3.35	2.59	2.16	3.75	3.05	2.42	2.09	2.96	2.27	3.83	2.78	2.91	3.54	2.76	3.52	2.46	5.10	4.12	4.36
22. Plumbing	1.42	2.73	2.38	2.00	2.45	1.93	.95	2.37	1.78	1.48	2.29	1.96	2.14	1.46	1.94	1.66	2.88	1.84	2.08	2.03	1.96	2.35	2.94	2.53	2.69	2.95
23. Roofing	5.16	12.98	7.49	10.30	9.31	7.77	3.75	8.89	7.08	6.91	10.70	8.65	8.39	5.47	7.19	5.44	9.57	7.05	7.48	9.61	12.67	9.01	8.42	12.51	11.79	10.98
24. Sheet metal work	2.03	5.66	5.99	11.61	3.59	2.75	1.40	3.56	2.09	2.24	3.43	2.75	2.80	2.04	2.76	2.31	3.66	2.72	2.83	2.10	3.08	3.06	6.25	3.43	3.88	4.20
25. Steel erec.— struct. or on outside bldg	12.00	33.67	30.61	17.30	21.58	14.78	6.90	19.96	10.30	11.04	21.40	13.58	11.66	10.48	15.82	12.75	16.80	15.91	16.43	21.93	19.76	18.33	22.39	34.21	22.27	25.22
26. Steel, iron, brass & bronze erec., int. orn.	2.36	4.43	7.00	3.73	4.23	3.31	6.90	3.98	2.45	2.61	4.30	3.43	2.66	2.31	3.32	2.63	4.39	3.17	3.24	4.41	3.77	3.81	7.35	4.74	4.73	4.98
27. Steel erection — general	8.55	19.46	23.39	10.36	15.65	11.61	6.90	14.67	12.72	9.29	16.14	12.99	8.03	8.30	12.21	9.53	15.57	11.65	11.44	17.44	12.68	13.47	19.06	19.67	17.03	18.33
28. Supervising officers or executives (4)	.32	.88	.90	.49	.59	.36	G	.57	.35	.30	.48	.44	.37	.31	.46	.38	.58	.43	.49	.49	.50	.49	.82	.67	.51	.69
29. Tile, stone, mosaic, terrazzo work — interior	1.13	1.79	1.39	1.67	1.94	1.55	.75	3.73	1.24	1.24	1.89	1.64	1.24	1.16	1.58	1.20	2.08	1.50	1.53	1.95	1.77	1.86	1.39	2.18	2.19	2.31
30. Watchmen and timekeepers (5)	1.61	6.36	6.57	G	2.83	2.35	G	2.70	1.69	1.89	2.96	2.28	1.81	1.62	2.25	1.75	2.93	2.14	2.17	3.06	2.50	2.58	5.41	3.16	3.36	3.33
31. Waterproofing	2.54	5.63	3.19	4.34	4.34	3.61	W	4.19	2.57	2.87	4.62	3.67	2.77	2.53	3.52	2.69	4.74	3.31	3.39	4.76	4.02	4.19	3.33	4.94	5.14	5.17
32. Wrecking	17.34	35.22	22.80	26.14	31.72	15.97	13.80	27.87	18.16	13.03	22.00	26.97	18.16	17.58	22.39	19.64	29.21	23.89	22.81	20.91	34.14	20.78	23.44	34.36	24.36	37.34

Classification of Work (1)	Nev.(F)	N. H.	N. J.	N. M.	N. Y.	N. C.	N.D.(F)	Ohio(F)	Okla.	Ore.(H)	Pa.	R. I.	S. C.	S. D.	Tenn.	Tex.	Utah	Vt.	Va	Wash.(H)	W.Va.(F)	Wisc.	Wyo.(F)
1. Boiler installation	State Insurance Plan Nevada Industrial Commission, Carson City, Nev.	4.94	7.60	4.47	9.09	5.18	North Dakota State Plan: Workmen's Compensation Bureau, Bismarck, N. D.	Ohio State Plan: Workmen's Compensation, The Industrial Commission of Ohio, Actuarial Section, Columbus, Ohio	10.87	9.20	7.20	7.94	7.02	5.04	4.61	5.24	9.90	3.53	3.77	7.07	West Virginia State Plan: State Compensation Commission Charleston, W. Va.	7.01	Wyoming State Plan: Manager, Workmén's Compensation Dept., State Treasurer's Office, Cheyenne, Wyo.
2. Carpentry, private or 2-family residences		3.03	5.50	3.16	9.25	2.57			6.91	6.36	3.65	4.85	4.65	3.07	2.73	4.11	5.00	2.21	2.19	4.59		5.97	
3. Carpentry, 3 stories or less — dwellings		3.03	6.30	3.16	9.25	2.57			6.91	6.36	3.65	4.85	4.65	3.07	2.73	4.11	5.00	2.21	2.19	4.59		5.97	
4. Carpentry, interior trim installation		1.48	S	1.72	9.25	1.53			3.32	2.94	3.65	2.33	1.62	1.54	1.43	2.45	2.99	1.09	1.50	1.50		5.97	
5. Carpentry, general		5.19	7.20	5.08	9.25	4.14			14.77	7.49	3.65	8.20	7.91	5.07	5.16	7.74	6.50	3.49	3.92	6.08		5.97	
6. Cement wk., sidewalks, drives & cellar floors		1.88	4.30	1.82	5.58	1.93			4.21	3.19	5.25	2.93	2.35	1.96	1.83	2.68	3.77	1.35	1.57	2.30		2.04	
7. Conc. const.— bridges & culv. monolithic (2)		7.78	10.90	7.99	12.49	9.35			24.29	11.58	8.25	12.17	12.48	7.78	8.50	7.74	15.41	5.30	7.98	8.90		7.17	
8. Concrete construction — reinf. floors (2)		4.83	9.00	4.46	10.62	5.70			13.45	6.69	8.25	7.91	8.71	4.99	4.26	7.74	10.83	3.47	3.80	5.15		7.67	
9. Conc. const.— dwgs 3 stor.— not mono. (2)		3.44	9.00	2.54	10.62	2.59			4.05	5.83	8.25	5.47	3.92	2.31	2.58	7.74	4.50	2.84	1.99	4.48		3.21	
10. Concrete construction, general (2)		4.83	9.00	4.46	10.62	5.70			13.45	6.69	8.25	7.91	8.71	4.99	4.26	7.74	10.83	3.47	3.80	5.15		7.67	
11. Electrical equipment installation		2.18	3.70	2.70	4.97	2.11			4.91	4.15	1.65	3.51	3.38	2.25	2.28	4.02	4.57	1.60	2.29	3.11		3.78	
12. Electrical wiring — within buildings		1.43	2.35	1.59	3.75	1.72			3.21	3.29	1.65	2.31	2.14	1.47	1.53	2.47	2.90	1.06	1.41	2.53		2.37	
13. Excavation — earth (3)		3.89	7.50	4.65	10.29	3.80			8.87	7.46	5.25	6.16	5.34	4.26	3.28	6.26	7.50	2.81	2.38	5.39		5.77	
14. Excavation — rock (3)		D5.19	10.30	D4.95	D10.29	D7.07			D11.65	13.97	5.25	D8.38	D9.70	D5.31	D4.86	8.64	D10.46	D3.73	D4.10	D10.49		8.42	
15. Glazing		3.98	7.00	4.22	12.79	4.15			8.93	6.73	2.90	6.33	5.37	4.13	3.81	6.72	8.04	2.87	3.63	5.17		7.02	
16. Lathing		2.01	4.50	2.30	5.45	2.07			4.46	5.72	2.40	3.16	3.32	2.04	1.88	3.41	3.50	1.41	1.96	4.04		3.31	
17. Masonry, brick, stone or conc. block		3.44	7.40	2.54	9.23	2.59			4.05	5.83	5.20	5.47	3.92	2.31	2.58	7.74	4.50	2.84	1.99	4.48		3.21	
18. Office workers		.06	.09	.07	.10	.07			.08	.09	.07	.10	.09	.09	.07	.10	.12	.07	.06	.07		.10	
19. Painting and decorating		2.94	6.70	3.43	9.90	2.93			6.67	6.67	4.15	4.76	3.59	3.15	2.43	4.52	6.29	2.20	3.01	5.13		3.64	
20. Painting steel structures & bridges		14.56	23.00	15.56	S	16.31			32.64	25.39	15.00	23.73	19.63	14.58	12.36	32.29	29.00	10.28	12.05	19.52		17.32	
21. Plastering		2.54	4.50	2.79	6.54	2.48			5.69	5.72	2.40	3.99	3.32	2.60	2.24	4.16	4.50	1.80	2.43	4.04		3.19	
22. Plumbing		1.69	3.10	1.77	4.33	1.78			3.71	2.91	2.25	2.57	2.31	1.71	1.63	2.93	2.50	1.26	1.52	2.24		2.70	
23. Roofing		6.41	10.70	7.98	R18.99	6.65			14.08	15.59	8.20	10.01	9.15	6.47	5.76	10.90	11.00	4.53	5.64	11.97		14.48	
24. Sheet metal work		2.41	14.60	2.59	7.40	2.69			5.37	6.42	3.05	3.86	3.59	2.46	2.46	3.66	4.71	1.75	2.15	4.59		4.19	
25. Steel erec.— struct. or on outside bldg		14.56	23.00	15.56	48.28	15.31			32.64	25.39	15.00	23.73	19.63	14.58	12.36	32.29	29.00	10.28	12.05	19.52		17.32	
26. Steel, iron, brass, bronze; int. orn.		2.86	6.40	3.23	5.91	2.99			6.45	5.94	15.00	4.60	3.46	2.93	2.66	4.79	5.75	2.04	2.70	4.57		4.91	
27. Steel erection — general		10.53	19.20	11.79	27.58	12.23			31.17	16.88	15.00	17.05	14.62	10.65	10.43	15.56	21.10	7.52	9.28	12.98		14.76	
28. Supervising officers or executives (4)		.41	.80	.36	.85	.45			.88	.75	G	.67	.68	.40	.36	G	.79	.29	.29	.58		.73	
29. Tile, stone, mosaic, work — interior		1.34	1.95	1.45	3.25	1.40			2.98	2.10	1.65	2.10	1.53	1.35	1.29	1.73	2.68	.95	1.27	1.62		2.23	
30. Watchmen and timekeepers (5)		1.91	S	2.23	6.80	2.01			4.26	5.45	G	3.04	2.85	1.96	1.81	G	3.84	1.38	1.94	4.69		5.00	
31. Waterproofing		2.98	6.30	3.47	W	3.07			6.74	4.70	W	4.71	3.80	3.09	2.83	5.17	5.98	2.12	2.96	3.61		5.00	
32. Wrecking		21.46	31.70	16.44	B	21.81			48.11	32.43	30.00	34.31	32.77	21.93	22.01	27.12	43.09	15.34	13.51	24.93		32.77	

(1) Blasting payroll is assigned to operation to which blasting is incidental, except Cal. $16.07 rate applies. (2) Includes construction of forms. (3) No pile driving, caisson or coffer dam work. (4) Not applicable to executive supervisors assigned to single job or location. (5) Watchmen and Timekeepers take governing class if general contractor is conducting any operations on job. (A) Subject to increase or decrease according to experience ratings. (B) Building Wrecking in N. Y. rated on basis of cubic content. (D) Special rate charges for Occupational Disease. (E) Employers Liability — No Compensation Act. (F) Compensation must be carried with State Fund. (G) Assign to governing classification. (H) Occupations specified as hazardous in Compensation Law must be insured in State Fund. (J) Lead Burning operation subject to special rating. (M) Due rate for outside work; inside painting $.57 rate applies in Mass. (P) Classification of these operations pending with State Authorities. (R) For flat roof work — $16.41 applies in N. Y. (S) Specially rated by Bureau. (W) Waterproofing in Del., N. Y. & Pa. specially rated according to type.

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BRANCHES IN 59 OF THE COUNTRY'S PRINCIPAL CITIES

Small House Costs In 79 Cities

THE CUBIC-FOOT COST of building the same standard house in 79 representative U. S. cities is computed by the Federal Home Loan Bank Board. The cities reporting are divided into 3 groups or cycles, of which one cycle is given each month. Thus, the costs in each city are available four times a year.

In determining the cubic content of the house, length and width are taken as the actual measurement of the outside walls. Height is the distance from 6 inches below the finished surface of cellar floor to a point halfway between roof ridge and attic floor beams. Multiplying these factors gives the gross cube.

The house on which costs are reported is a detached 6-room home of 24,000-cu.ft. volume. Living room, dining room, kitchen and lavatory on first floor; 3 bedrooms and bath on second floor. Exterior is wide-board siding with brick and stucco as features of design. Best quality materials and workmanship are used.

The house is not completed ready for occupancy. It includes all fundamental structural elements, an attached 1-car garage, an unfinished cellar, an unfinished attic, a fireplace, essential heating, plumbing and electric wiring equipment, and complete insulation. It does not include wall-paper nor other wall or ceiling finish on interior plastered surface, lighting fixtures, refrigerators, water heaters, ranges, screens, weather stripping, nor window shades.

Reported costs include, in addition to material and labor costs, compensation insurance, an allowance for contractor's overhead and transportation of materials, plus 10 per cent for builder's profit.

Reported costs do not include the cost of land nor of surveying the land, the cost of planting the lot, nor of providing walks and driveways; they do not include architect's fee, cost of building permit, financing charges, nor sales costs.

In figuring costs, current prices on the same building materials list are obtained every three months from the same dealers, and current wages are obtained from the same reputable contractors and builders.

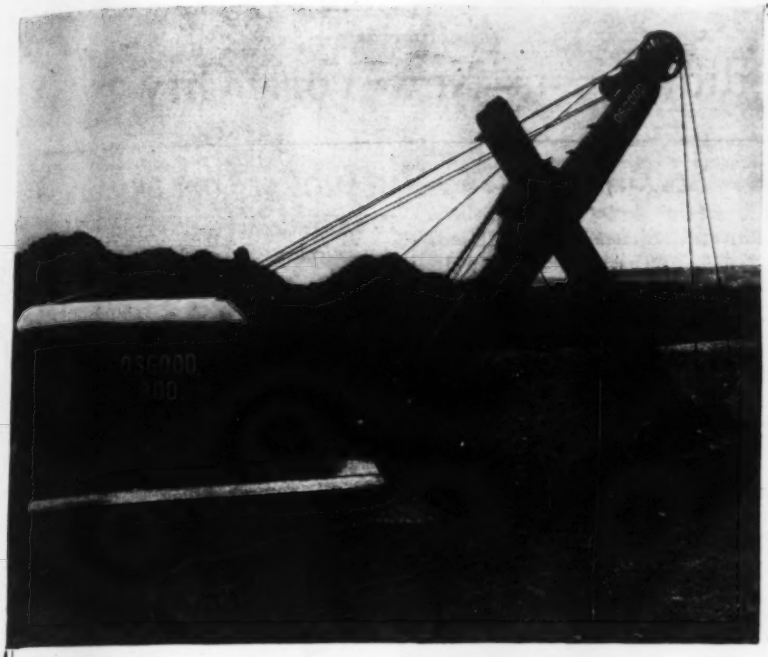
Small House Costs—Cents Per Cubic Foot

Federal Home Loan Bank Board

	1937				1938				1939				1940	
	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.
Albany, N. Y.	.230	.238	.242	.245	.246	....	.236	.232	.228	.233	.230	.233	.234	.237
Atlantic City, N. J.	.256	.273	.257	.252	.247	....	.247	.246	.241	.239	.244	.261	.261	.253
Boise, Idaho	.249	.255	.256	.257	.247	.244	.244	.250	.253	.257	.257	.255	.259	.261
Buffalo, N. Y.	.232	.243	.255	.256	.246	.238	.242	.247	.240	.236	.234	.246	.247	.238
Camden, N. J.	.230	.245	.245	.245	.238	.237	.238	.232	.233	.237	.232	.243	.248	.248
Casper, Wyo.	.260	.266	....	.273	.272	.270	.269	.268	.269	.272	.272	.275	.278	.261
Des Moines, Iowa	.256	.267	.269	.269	.261	.256	.255	.257	.262	.261	.262	.263	.264	.264
Detroit, Mich.	.229	.252	.264	.259	.254	.251	.256	.257	.258	.255	.255	.247	.242	.243
Duluth, Minn.	.237	.246	.261	.262	.260	.258	.258	.258	.249	.250	.250	.252	.258	.258
Evansville, Ind.	.230	.242	.242	....	.240	.240	....	.239	.244	.240	.246	.254	.255	.255
Fargo, N. D.	.239	.249	.251	.249	.248	.245	.243	.243	.236	.236	.234	.243	.244	.244
Grand Rapids, Mich.	.219	.231	.241	.243	.246	.246	.246	.245	.246	.243	.243	.236	.229	.230
Great Falls, Mont.	.274	.293	.293	.293	.292	.297	.296	....	.291	.293	.289	.287	.290	.288
Indianapolis, Ind.	.229	.243	.244	....	.238	.242	.242	.240	.243	.249	.248	.239	.233	.229
Kansas City, Mo.	.227	.241	.260	.254	.243	.239	.240	....	.242	.248	.255	.248	.251	.250
Newark, N. J.	.223	.236	.236	....	.223	.226	.228	.231	.231	.231	.229	.236	.238	.238
Portland, Ore.	.222	.243	.247	.251	.222	.218	.212	.219	.221	.212	.214	.220	.223	.222
St. Louis, Mo.	.259	.275	.272	.268	.259	.255	.251	.250	.253	.252	.248	.252	.257	.255
St. Paul, Minn.	.249	.265	.284	.284	....	.272	.273	.272	.272	.274	.273	.273	.272	.271
Salt Lake City, Utah	.237	.247	.253	....	.252	.248	.246	.245	.245	.251	.251	.250	.251	.251
Seattle, Wash.	.255	.276	.275	.272	.271	.268	.261	.261	.261	.263	.261	.263	.263	.265
Sioux Falls, S. D.	.243	.250	.257	.264	.264	.258	.266	.268	.261	.259	.251	.252	.254	.257
South Bend, Ind.	.244	.252	.251	....	.242	.232	.223	.223	.226	.229	.231	.244	.242	.246
Spokane, Wash.	.266	.273	.283	.285	.273	.273	.276	.262	.250	.254	.255	.262	.263	.263
White Plains, N. Y.	.239	.246	.250	.244	.235	.232	....	.231	.231	.229	.226	.231	.233	.233

	1937				1938				1939				1940
	Feb.	May	Aug.	Nov.	Feb.	May	Aug.	Nov.	Feb.	May	Aug.	Nov.	Feb.
Albuquerque, N. M.	.269	.277	.279	.277	.274	.275	.277	.272	.272	.267	.267	.263	.261
Charleston, W. Va.	.236	.245	.262	.260	.259	.248	.246	.245	.244	.244	.242	.243	.243
Cincinnati, Ohio	.237	.248	.252	.251	.248	....	.243	.233	.229	.230	.229	.232	.230
Cleveland, Ohio	.263	.281	.291	.286	.274	....	.267	.267	.268	.270	.270	.285	.283
Columbus, Ohio	.247	.260	.268	.254	.237	.237	.247	.239	.237	.235	.234	.241	.242
Dallas, Tex.	.246	.253	.253	.253	....	.242	.245	.239	.239	.235	.228	.226	.222	.226
Harrisburg, Pa.	.240	.250	.250	.243	.242	.243	.237	.237	.238	.238	.239	.254	.245
Houston, Tex.	.247	.258	.257	.256	.249	.245	.250	.246	.246	.246	.245	.244	.247
Jackson, Miss.	.234	.245	.254	.249	.253	.255	.253	.253	.251	.246	.246	.251	.251
Lexington, Ky.	....	.233	.238	.233	.225	.222	.222	.228	.236	.235	.238	.246	.246
Little Rock, Ark.	.216	.220	.217	.216	.215	.215	.215	.217	.216	.218	.218	.216	.216
Los Angeles, Cal.	.242	.250	.250	.247	.245	.238	.238	.228	.225	.220	.218	.221	.219
Louisville, Ky.	....	.233	.228	.224	.220	.214	.216	.218	.218	.219	.218	.225	.225
Memphis, Tenn.	.227	.230	.228	.228	.221	.222	.221	.224	.227	.222	.220	.226	.225
Nashville, Tenn.	.220	.226	.229	.228	.214	.209	.212	.213	.212	.208	.206	.209	.207
New Orleans, La.	.231	.239	.244	.248	.248	.248	.244	.242	.237	.235	.235	.244	.243
Philadelphia, Pa.	.230	.249	.249	.240	.230	.232	.226	.224	.225	.226	.229	.233	.233
Phoenix, Ariz.	.252	.281	.283	.281	.279	.274	.270	.269	.257	.252	.255	.259	.258
Pittsburgh, Pa.	.265	.281	.283	.280	.271	.280	.270	.267	.269	.267	.268	.267	.261
Reno, Nev.	.265	.276	.278	.278	.276	.273	.273	.274	.274	.273	.274	.279	.281
San Antonio, Tex.	.243	.260	.260	.259	.254	.252	.252	.247	.245	.245	.244	.237	.233
San Diego, Cal.	.256	.254	.256	.258	.254	.244	.243	.243	.241	.238	.234	.228	.226
San Francisco, Cal.	.262	.267	.269	.266	.265	.264	.264	.265	.266	.265	.263	.263	.263
Wheeling, W. Va.	.246	....	.271	.277	....	.262	.252	.250	.258	.262	.263	.264	.263
Wilmington, Del.	.229	.241	.242	.242	.246	.246	.246	.246	.240	.233	.226	.225	.225

	1937				1938				1939				1940
	Mar.	June	Sept.	Dec.	Mar.	June	Sept	Dec.	Mar.	June	Sept.	Dec.	Mar.
Asheville, N. C.	....	.218	....	.225	.225	.216	.212	.211	.212	.203	.202	.213	.208
Atlanta, Ga.	.218	.221	.227	.219	.216	.217	.211	.209	.203	.201	.200	.205	.205
Baltimore, Md.	.224	.224	.224	.215	.213	.208	.206	.205	.205	.209	.207	.211	.209
Birmingham, Ala.	....	.252	.253	.253	.253	.253	.244	.236	.236	.221	.215	.216	.219
Boston, Mass.	.267	.277	.278	.275	.258	.253	.262	.266	.266	.262	.264	.268	.270
Chicago, Ill.	.293	.301	.299	.301	.293	.288	.284	.285	.285	.285	.282	.283	.283
Columbia, S. C.	.200	.203	.203	.203	.198	.199	.203	.204	.202	.199	.197	.195	.197
Cumberland, Md.	.236	.239	.237	.235	.233	.231	.230	.227	.230	.231	.228	.228	.235
Denver, Colo.	.269	.280	.282	.276	.273	.269	.274	.268	.265	.266	.262	.259	.259
Hartford, Conn.	.252	.264	.264	.253	.243	.236	.242	.245	.244	.243	.243	.246	.247
Manchester, N. H.	.236	.242	.242	.233	.227	.225	.226	.231	.229	.226	.222	.224	.225
Milwaukee, Wis.	.247	.249	.251	.251	.242	.240	.240	.240	.249	.250	.248	.252	.253
New Haven, Conn.	.241	.246	.246	.243	.240	.234	.234	.234	.235	.233	.236	.241	.244
Oklahoma City, Okla.	.237	.243	.243	.244	.244	.243	.243	.245	.245	.244	.246	.250	.252
Omaha, Neb.	.247	.249	.255	.249	.243	.242	.242	.238	.241	.241	.248	.253	.257
Oshkosh, Wis.	.242	.253	.256	.251	.252	.252	.246	.246	.245	.247	.246	.242	.246
Peoria, Ill.	.273	.284	.284	.279	.279	.279	.270	.268	.268	.273	.277	.288	.293
Portland, Me.	.219	.238	.242	.238	.231	.230	.221	.219	.219	.221	.219	.218	.219
Providence, R. I.	.240	.247	.247	.250	.250	.247	.246	.246	.247	.250	.248	.250	.251
Raleigh, N. C.	.228	.234	.236	.230	.227	.226	.221	.220	.219	.206	.202	.216	.213
Richmond, Va.	.217	.218	.222	.224	.222	.219	.211	.212	.212	.206	.208	.206	.202
Roanoke, Va.	.210	.214	.209	.213	.211	.211	.212	.212	.214	.215	.215	.216	.217
Rutland, Vt.	.238	.241	.244	.244	.239	.236	.231	.228	.228	.226	.223	.220	.222
Salisbury, N. C.	....	.194	.197	.196	.196	....	.198	.198	.197	.195	.194	.203	.203
Springfield, Ill.	.288	.291	....	....	.290	.290	.284	.284	.284	.283	.282	.295	.295
Tampa, Fla.	.232	.238	.238	.232	.236	.234	.231	.230	.231	.232	.232	.238	.238
Washington, D. C.	.239	.249	.251	.251	.249	.250	.243	.244	.242	.236	.239	.239	.239
West Palm Beach, Fla.	.266	.269	.269	.266	.261	.257	.242	.243	.241	.241	.238	.239	....
Wichita, Kan.	.233	.238	.237	....	.237	.244	....	.249	.254	.251	.253	.246	.248



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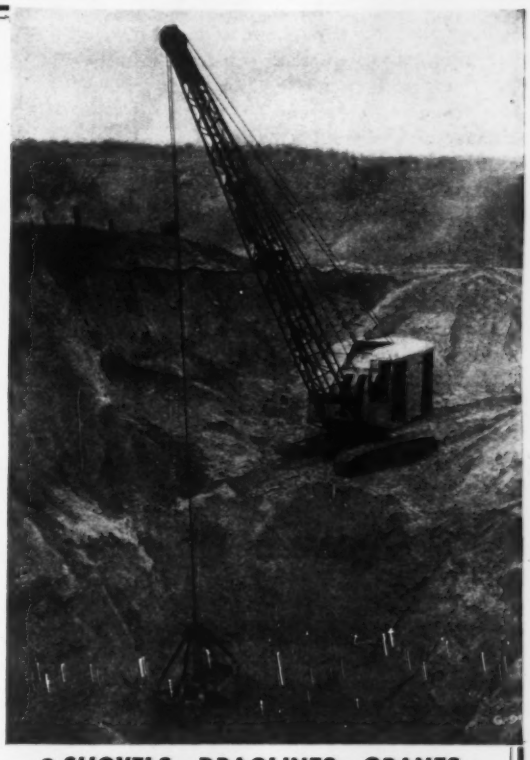


● SHOVELS—DRAGLINES—CRANES
½—⅝—¾ Cu. Yard Capacities

Municipal Building Costs–New York City

The various types of buildings listed were designed, constructed and completed under supervision of the Department of Public Works, New York, N. Y., Irving V. A. Huie, Commissioner.

MARKETS

Fish Market—3-story steel frame, asbestos walls, includes wood pile dock with concrete deck. Capacity 16 stores.

Cubic foot cost	$0.32
Square foot cost	$7.00

Retail Market—1-story (no cellar), four buildings, fireproof, brick walls, concrete floors and roof. Part load bearing walls and part steel frame construction, steel sash and doors. Capacity 518 stands.

Cubic foot cost	$0.345
Square foot cost	$8.60

Retail Market (PWA project)—1-story and cellar brick and concrete fireproof building, facing 3 streets; first floor skeleton steel framing and cellar reinforced concrete construction. Reinforced concrete floor and roof slabs, terra cotta coping, metal stationary and pivoted windows. Capacity 135 stands.

Cubic foot cost	$0.29
Square foot cost	$9.50

Meat Market—3-story steel frame reinforced concrete walls and floors, pile foundation.

Cubic foot cost	$0.43
Square foot cost	$6.00

Retail Market (WPA project)—1-story fireproof building facing on two streets with cellar. Brick facing.

Cubic foot cost	$0.32 est.
Square foot cost	$10.50 est.

COURT BUILDINGS

General Court (PWA project)—7-stories and basement, steel frame construction, enclosed brick walls, with limestone facing and fireproof construction. Approximately 274 x 160 ft. 19 court rooms.

Cubic foot cost	$0.91
Square foot cost	$14.96

Court (PWA project)—2-story and basement rectangular in shape with overall dimensions of 180x87 ft. Fireproof structure, exterior walls are light gray granite backed with brick, steel windows, exterior doors are copper covered. Air conditioning throughout. One court room.

Cubic foot cost	$1.05
Square foot cost	$23.59

Family Court (PWA project)—11-story building with 2-story penthouse and basement, approximately 75x100 ft. Skeleton steel frame, fireproof construction, enclosed on street frontages with polished granite and limestone. Pier foundations to rock.

Cubic foot cost	$0.86
Square foot cost	$12.72

HOSPITAL BUILDINGS

Hospital—Comprises 6 buildings: 1 administration bldg., 1 laboratory and 4 ward bldgs. Administration building 5 stories and basement; laboratory 3 stories and basement; wards 4 stories and basement. All buildings linked by connecting corridors, 2-story and basement in height. Group occupies approximately 375 x 1,000 ft., all skeleton steel frame, fireproof and enclosed in brick trimmed with stone.

Cubic foot cost	$0.78
Square foot cost	$12.21

Nurses' Home—"U"-shaped building, approx. 125 ft. long, 2 wings, 36x51 ft. Main building 4 stories and basement. Wings 3 stories and basement. Steel frame, brick walls, concrete pile foundations.

Cubic foot cost	$0.76
Square foot cost	$9.00

Nurses' Home—Central unit 12 stories and basement with 2 wings, each 9 stories and basement. Construction is fireproof with exterior walls of brick and spandrels of lead. Roof covered with tile. Quarters 679 members of nursing staff.

Cubic foot cost	$0.74

HEALTH CENTER BUILDINGS

Health Center—Basement and 6 stories, planned for additional 2 stories, fireproof construction. Spread footings, skeleton steel frame, brick facing, back-up tile walls, simplon furring. Limestone trim, double-hung windows. Republic floor slab. 2 automatic elevators.

Cubic foot cost	$0.77
Square foot cost	$9.17

Health Center—Basement and 7 stories, brick facing with back-up tile walls and limestone trim. Steel skeleton frame, foundations to rock. 2 automatic elevators.

Cubic foot cost	$0.77
Square foot cost	$9.25

Health Center (PWA project)—1-story, penthouse and basement, skeleton steel frame, fireproof construction. Walls of brick trimmed with stone. Irregular plot, approx. 100x70 ft.

Cubic foot cost	$0.81
Square foot cost	$13.80

SANITATION GARAGE

Garage—2-story, no basement, steel skeleton frame, face brick, pile foundation, steel sash windows.

Cubic foot cost	$0.22
Square foot cost	$6.91

Garage—1- and 2-story, red face brick, steel sash throughout, hand operated doors; steel skeleton frame.

Cubic foot cost	$0.27

MISCELLANEOUS

Freight Warehouse (WPA project)—1-story steel frame, wood roof, masonry walls.

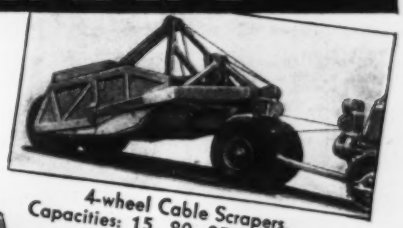
Cubic foot cost	$0.44
Square foot cost	$7.50

NOTE: Cubic foot cost includes excavation, foundations, general construction, plumbing, heating and ventilating, electrical work, lighting fixtures, elevators, and built-in equipment. Items excluded are furniture, architects and engineering fees and land costs.

Square foot costs are approximate and based on gross square foot area.

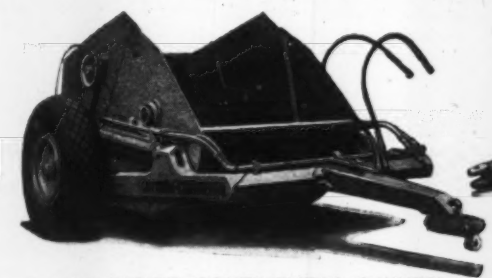
GAR WOOD
ROAD MACHINERY

Advanced engineering and rugged construction make the new 1940 Gar Wood Road Machinery the finest obtainable! The efficient system of operation insures faster and more economical performance. Gar Wood Road Machinery is preferred *because it excels!*



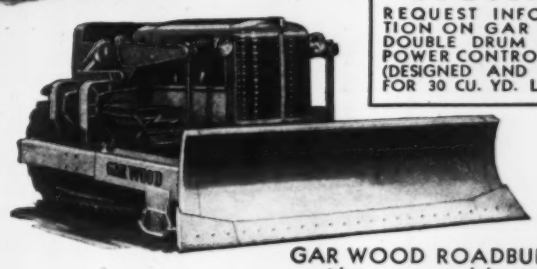
4-wheel Cable Scrapers. Capacities: 15, 20, 25 cubic yards.

GAR WOOD 4-WHEEL earth-moving SCRAPERS (shown at right) dig, load, dump and spread. Outstanding for fast operation. Capacities: 8, 10, 12, 15 and 20 cubic yards.

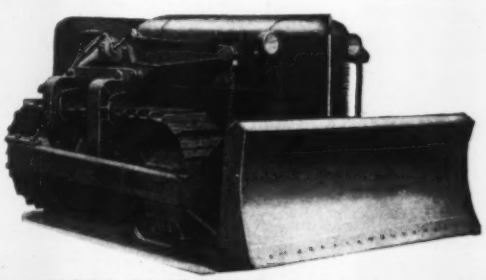


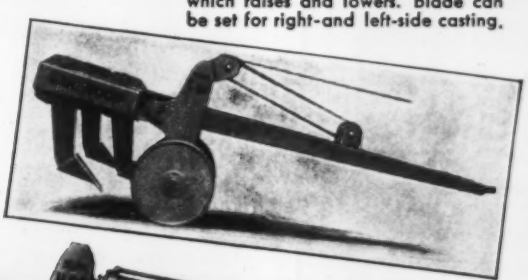
SPECIAL
REQUEST INFORMATION ON GAR WOOD DOUBLE DRUM CABLE POWER CONTROL UNIT (DESIGNED AND TESTED FOR 30 CU. YD. LOADS).

GAR WOOD CONTINENTAL 2-WHEEL earth-moving SCRAPERS (above) load, haul, and back dump. Light in weight and outstanding for fast operation. Capacities: 3, 5, 6, 8 and 10 cubic yards.

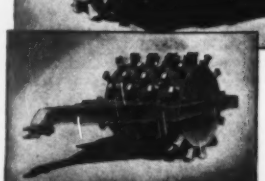


GAR WOOD ROADBUILDERS provide power up and down on blade which raises and lowers. Blade can be set for right-and left-side casting.





GAR WOOD BULLDOZERS provide power up and power down on blade with quick control to regulate cut.



GAR WOOD RIPPERS for tractors are used for ripping compacted earth, shale, rock, roots, old pavements and old roads.

SHEEP-FOOT TAMPING ROLLERS pack fills. Available in single, double or triple units or tandem combinations.

Literature fully describing the new 1940 line of Gar Wood Road Machinery sent promptly on request.

GAR WOOD INDUSTRIES, INC., Detroit, Michigan
ROAD MACHINERY DIVISION
ROADBUILDERS • BULLDOZERS • SCRAPERS • TAMPING ROLLERS • RIPPERS

Cost Summary of Selected U.S.H.A.-Aided Housing Projects

Location and Name of Project	No. of Units	No. of Rooms	Height (in stories)	Estimated Over-all Cost Per Dwelling Unit						Est. New Housing Cost [7]
							Dwelling Facilities			
				Total [1]	Land [2]	Non-dwell. Facilities [3]	Total [4]	Net Const. Cost [5]	Equip., Fees, Overhead [6]	
Annapolis, Md., College Creek Terr	108	434	2	$4,115	$68	$566	$3,481	$2,810	$671	$
Anniston, Ala.	164	696	2	3,449	147	412	2,890	2,245	645	
Atlanta, Ga., Clark Howell Homes	630	2,649	2&3	4,756	452	624	3,680	3,023	657	
Baltimore, Md., Armistead Gardens	700	2,798	1&2	3,149	60	622	2,467	2,077	390	
Birmingham, Ala., Elyton Village	860	3,687	1,2&3	4,659	399	587	3,673	3,019	654	
Boston, Mass., Charlestown	1,089	4,733½	3	4,622	514	463	3,645	2,992	653	
Bridgeport, Conn., Yellow Mill Village	1,251	5,434	3&4	4,196	427	426	3,343	2,738	605	
Bristol, Va., Wm. L. Rice Terr	136	591½	2	3,631	244	443	2,944	2,393	551	
Johnson Court	68	290	2	3,500	161	416	2,923	2,362	561	
Brownsville, Tex., Buena Vida	150	679	1&2	3,627	274	645	2,708	2,250	458	
Buffalo, N. Y., Commodore Perry	772	2,938½	2&3	5,134	470	722	3,942	3,332	610	
Butte, Mont., Silver Bowl Homes	225	908½	2	4,461	170	539	3,752	3,028	724	
Charleston, S. C., Charleston	128	522	1	3,756	480	487	2,789	2,305	484	
Charleston, W. Va., Washington Manor	304	1,222	3	4,472	352	622	3,498	2,824	674	
Charlotte, N. C., Fairview Homes	452	1,988	2	2,839	46	248	2,545	2,074	471	
Chattanooga, Tenn., College Hill	497	1,999½	2&3	4,426	285	577	3,564	2,911	653	
Chicago, Ill., Ida B. Wells Homes	1,662	6,901	2,3&4	5,223	467	627	4,129	3,487	642	
Cleveland, Ohio, Valleyview Homes	582	2,479½	2	5,464	508	789	4,167	3,441	726	
Columbia, S. C., Gonzales Gardens	236	966	2	3,874	293	484	3,097	2,487	610	
Columbus, Ga., Booker T. Washington	288	1,228	2	3,256	197	306	2,753	2,240	513	
Covington, Ky., Latonia Terr	235	1,069½	2&3	5,128	291	1,166	3,671	3,022	649	
Detroit, Mich., Brewster Addition	240	989	2&3	6,276	833	892	4,551	3,738	813	
Fall River Mass., Sunset Hills	356	1,571½	1&2	4,715	156	636	3,923	3,193	730	
Frankfort Ky., Leestown Terr	91	354½	1	3,715	106	763	2,846	2,270	576	
Great Falls, Mont., Parkdale	156	651	1&2	4,721	78	828	3,815	2,922	893	
Houston, Tex. Cuney Homes	360	1,474	2	4,037	109	599	3,329	2,740	589	
Knoxville, Tenn., Austin Homes	200	862	2	4,093	159	646	3,288	2,599	689	
Laurel, Miss., Beacon Homes	150	642	1&2	3,749	149	495	3,105	2,583	522	
Los Angeles County, Calif., Carmelitos	607	2,644½	2	4,013	52	756	3,205	2,581	624	
Louisville, Ky., East End	786	3,377	2&3	4,810	570	715	3,525	2,920	605	
Lowell, Mass., North Common Village	536	2,232½	2&3	4,914	479	488	3,947	3,202	745	
Memphis, Tenn., Wm. H. Foote Homes	900	3,681	2	4,322	416	535	3,371	2,733	638	
Meridian, Miss.	80	333	2	3,619	86	591	2,942	2,378	564	
Miami, Fla., Edison Courts	345	1,356½	1&2	4,230	165	556	3,509	2,850	659	
Mount Hope, W. Va., Stadium Terr	70	315	2	4,384	126	823	3,434	2,838	597	
Muncie, Ind., Munsyana Homes	278	1,112	2	3,779	387	453	2,939	2,421	518	
Newark, N. J., Orange and Nesbit	614	2,604	3	5,073	537	621	3,915	3,232	683	
New Orleans, La., St. Thomas St	970	3,794	2&3	5,179	480	738	3,961	3,222	739	
New York, N. Y., Red Hook Houses	2,583	10,656½	6	4,688	412	504	3,772	3,155	617	
Queensbridge Houses	3,161	12,967½	6	4,685	655	686	3,344	2,766	578	
Norwalk, Conn., Washington Village	136	608	2	4,281	119	573	3,589	2,805	784	
Omaha, Nebr., South Side Terr. Homes	522	2,269	2	4,567	105	773	3,689	3,021	668	
Pensacola, Fla., Attucks Court	120	485	1&2	3,839	130	658	3,051	2,348	703	
Peoria, Ill., Harrison Homes	606	2,701	2	4,252	117	580	3,555	2,899	656	
Philadelphia, Pa., Jas. Weldon Johnson Homes	535	2,034	2&3	5,927	571	1,017	4,339	3,587	752	
Pittsburgh, Pa., Terrace Village II	1,851	7,693½	3	5,047	305	1,344	3,398	2,780	618	
Reading, Pa., Glenside	400	1,722	2	4,865	150	823	3,892	3,122	770	
Rome, Ga., Altoview Terr	94	331	2	3,595	63	469	3,063	2,515	548	
San Antonio, Tex., Alazan Court	932	3,610	1&2	3,729	531	586	2,612	2,247	365	
San Francisco, Calif., Sunnydale	772	3,554½	1&2	3,505	121	621	2,763	2,294	469	
Trenton, N. J., Lincoln Homes	118	488	2&3	4,865	345	796	3,724	2,998	726	
Toledo, Ohio, Chas. F. Weiler Homes	384	1,600	2	5,050	310	1,064	3,676	2,996	680	
Utica, N. Y., Adrean Terr	213	925½	2&3	4,535	150	693	3,692	2,976	716	
Vincennes, Ind., Maj. Bowman Terr	83	368½	1	3,517	91	544	2,882	2,300	582	
Washington, D. C., Ridge Road	326	1,394	2&3	5,020	87	613	4,320	3,690	630	
Wilmington, N. C.	216	916	2	4,032	144	547	3,341	2,701	640	
Youngstown, Ohio, Westlake	618	2,466	2	4,863	295	1,034	3,534	2,926	608	
Honolulu, Hawaii, Kamehameha	221	968½	1&2	4,872	762	827	3,283	2,673	610	
Ponce, Puerto Rico, Ponce de Leon	300	1,200	2	1,749	197	259	1,293	1,091	202	

Table Footnotes:

[1] Consists of all costs of project except cost of slum buildings to be torn down, cost of land for future development, and local housing authority's administrative, carrying and contingent expenses applicable to these excepted items. The following items involved in some projects are not included since they are not properly chargeable to cost of new housing: (a) The cost of slum buildings to be torn down on the project site which represents an expenditure for slum clearance; and (b) the cost of land for future development which represents an expenditure for land which will later be used for additional housing. The exclusion of these two items makes possible fair comparisons between costs in USHA-aided projects and costs of private housing when land costs are included.

[2] Consists of cost of land to be purchased and value of land to be donated and to be used for present development. Includes also expenses of acquiring such land and the local housing authority's administrative, carrying, and contingent expenses applicable to such land. It does not include the cost of demolition or land for future development.

[3] Consists of the construction cost of site improvements and non-dwelling buildings, non-dwelling spaces and equipment, preoccupancy charges, and the local housing authority's architectural, administrative, carrying, and contingent applicable expenses.

[4] "Dwelling facilities cost" is the total of the construction cost of dwellings (referred to in footnote 5 as "Net construction cost"), dwelling equipment (ranges, refrigerators, screens, etc.), and local authority's architectural, administrative, carrying, and contingent expenses. Amount shown includes allowances for changes and extras.

[5] "Net construction cost" is the construction cost of dwellings — i.e., structural, plumbing, heating, and electrical costs. Amounts shown do not include any allowances for changes and extras. Items contained in "Net construction cost" most nearly comprise items contained in residential construction costs as compiled by the Bureau of Labor Statistics on basis of building-permit data.

[6] "Equipment, architects' fees, and overhead" consists of the cost of dwelling equipment (ranges, refrigerators, screens, etc.) and local authority's architectural, administrative, carrying, and contingent expenses applicable to dwelling construction and dwelling equipment.

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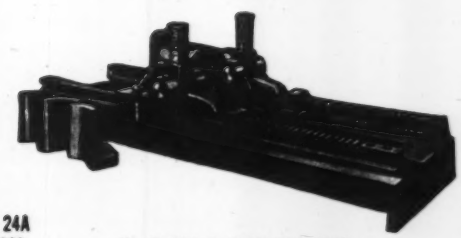

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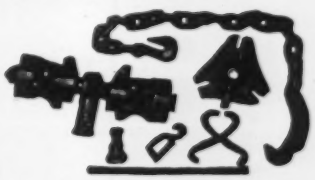

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Costs Facts on PWA-Financed Public Buildings in Eight States

Prepared in the Bureau of Labor Statistics, Division of Construction and Public Employment

Location	Kind of Bldg.	Description of Bldg.	Const. Contract Price	Per Cent Contract Price for			Cubic Content (cu. ft.)	Cost per cu. ft.
				Site labor	Material	Other expen., profit		
California								
San Francisco	School shop	Rein. conc.; conc. floors and roof	$156,371	23.7	54.4	21.9	376,000	$0.416
San Francisco	School	2-sty.; rein. conc.; conc. walls; stucco ext.	67,196	28.0	46.2	25.8	198,000	.339
Colorado								
Denver	Nurses' Home	3-sty.; rein. conc. fdn.; brick walls	91,295	32.2	51.0	15.8	216,044	.423
Denver	Hospital	2-sty.; rein. conc. fdn.; brick walls	41,289	34.6	56.2	9.2	125,600	.329
Georgia								
Atlanta	Auditorium	1-sty.; steel frame; rein. conc. walls; conc. fl. & roof	90,230	28.6	48.2	23.2	204,120	.442
Louisiana								
New Orleans	High School	3-sty.; steel frame; rein. conc. walls	705,423	28.6	46.4	25.0	2,330,000	.303
New Orleans	School	3-sty.; rein. conc. fdn.; st. frames; brick walls	216,097	32.8	46.4	20.8	780,000	.277
New Orleans	School	3-sty.; rein. conc. fdn.; st. frames; brick walls	209,809	32.8	47.2	20.0	780,000	.269
Massachusetts								
Boston	School	2-sty.; rein. conc. fdn.; brick walls	681,687	27.4	45.8	26.8	1,765,000	.386
Boston	School	3-sty.; rein. conc. fdn.; st. frame; brick walls	386,221	27.5	46.9	25.6	933,000	.414
Boston	School	2-sty.; rein. conc. fdn.; st. frame; brick walls	547,800	27.2	55.9	16.9	1,260,000	.435
Boston	Cafeteria	Rein. conc. fdn.; st. frame; brick walls	85,898	28.9	46.5	24.6	237,000	.362
New York								
Buffalo	Office Add'n	Add 2-sty. on 3-sty. st. frame; brick walls	156,090	27.8	48.1	24.1	375,000	.416
Buffalo	553 Housing	Rein. conc. fdn.; st. frame; brick walls	3,939,722	45.2	46.5	8.3	7,655,700	.515
New York	2 University	4-sty. rein. conc. fdn.; st. frame; brick walls	3,175,859	31.7	51.1	17.2	6,119,852	.519
New York	Library	2-sty. rein. conc. fdn.; st. frame; brick walls	416,084	33.3	51.7	15.0	532,489	.781
New York	Court	7-sty. rein. conc. fdn.; st. frame; brick walls	4,456,389	28.0	48.5	23.5	5,902,000	.755
New York	High School	4-sty. rein. conc. fdn.; st. frame; brick walls	2,976,563	28.8	47.7	23.5	6,723,500	.443
New York	Nurses' Home	5-sty. steel frame; conc. floor; brick walls	1,489,590	30.5	49.4	20.1	2,300,000	.648
New York	3 Housing	Rein. conc. fdn.; st. frame; brick walls	2,755,178	41.7	43.4	14.9	4,975,400	.554
New York	20 Housing	Conc. fdn.; steel frame; brick walls	8,507,234	37.7	39.8	22.5	15,239,000	.558
Ohio								
Cincinnati	Zoo	1-sty.; conc. fdn.; floors; brick walls	115,118	33.8	40.9	25.3	142,128	.810
Cincinnati	University	3-sty. rein. conc. fdn.; st. frame; brick walls	553,765	29.9	55.8	14.3	1,644,000	.337
Cincinnati	Hospital	1-sty. conc. fdn.; brick walls; rein. conc. fl. & roof	94,010	29.1	55.5	15.4	155,500	.605
Cincinnati	21 Housing	Conc. fdn.; st. frame; brick walls	4,530,269	37.1	40.4	22.5	8,622,100	.525
Cleveland	18 Housing	Rein. conc. fdn.; st. frame; brick walls	2,359,722	41.7	44.5	13.8	6,116,400	.385
Cleveland	330 Housing	Rein. conc. fdn.; st. frame; brick walls	2,425,325	43.8	41.0	15.2	6,152,600	.394
Toledo	School	1-sty.; brick walls	231,437	33.8	42.1	24.1	620,000	.374
Toledo	Library	1½-sty.; brick walls	39,592	27.1	56.0	16.9	135,500	.292
Toledo	3 University	3-sty.; stone walls	233,916	34.0	42.5	23.5	386,000	.606
Toledo	142 Housing	Rein. conc. fdn.; st. frame; brick walls	1,345,218	37.6	50.0	12.4	2,520,000	.534
Pennsylvania								
Harrisburg	Office	5-sty. rein. conc. fdn.; st. frame; br. & stone ext.	4,084,346	27.1	50.1	22.8	6,832,000	.598
Harrisburg	Armory	2-sty. rein. conc. fdn.; brick walls	75,636	30.9	54.1	15.0	350,000	.216
Philadelphia	Armory	2-sty.; rein. conc. fdn.; brick walls	156,816	30.4	44.9	24.7	400,700	.391
Philadelphia	School	1-sty. conc. fdn.; st. frame; brick walls	541,040	29.3	46.9	23.8	1,650,000	.328
Philadelphia	School	3-sty. rein. conc. fdn.; st. frame; brick walls	456,621	29.8	47.7	22.5	1,300,000	.351
Philadelphia	School	3-sty. conc. fdn.; steel frame; brick walls	495,670	29.4	46.6	24.0	1,132,000	.438
Philadelphia	196 Housing	Rein. conc. fdn.; st. frame; brick walls	1,614,053	38.0	45.9	16.1	3,090,100	.522

Expenditures by Type of Material on 47 PWA Low-Rent Housing Projects

Type of material	All projects	27 northern projects	20 southern projects		
			Total	6 without central heating	14 with central heating
All types	100.0 per cent	100.0 per cent	100.0 per cent	100.0 per cent	100.0 per cent
Electric wiring and fixtures	6.7	6.9	6.1	5.5	6.2
Forest products	10.2	10.0	10.8	14.6	9.7
Lumber and timber	5.5	5.2	6.5	8.6	6.0
Millwork	4.7	4.8	4.3	6.0	3.7
Iron and steel products	22.0	22.8	20.1	20.2	20.1
Metal doors and windows (glazed)	7.4	7.7	6.5	6.1	6.6
Hardware	2.2	2.2	2.3	2.8	2.3
Metal lath and channels	1.4	1.3	1.5	2.0	1.3
Reinforcing and structural steel	7.0	7.3	6.4	5.5	6.7
Wireworks products	.3	.3	.3	.2	.3
Other iron and steel products	3.7	4.0	3.1	3.6	2.9
Composition flooring and linoleum	1.4	1.4	1.3	1.5	1.2
Paints and varnishes	1.2	1.2	1.3	1.4	1.3
Heating and ventilating equipment	10.9	11.4	9.6	.6	12.0
Plumbing supplies and fixtures	13.0	12.5	14.6	15.4	14.4
Roofing and roof insulation	2.4	2.1	3.2	4.6	2.8
Sheet metal (copper)	.7	.6	.9	.8	1.0
Stone, clay, and glass products	30.4	29.9	31.3	34.5	30.5
Brick and hollow tile	9.8	10.2	8.7	8.2	8.8
Cement	3.9	3.4	5.2	2.7	5.9
Ceramic tile	.8	.7	.9	1.5	.7
Concrete products	9.4	9.7	8.7	13.9	7.4
Glass	.6	.7	.5	.8	.4
Marble, granite, etc.	1.1	1.0	1.1	.8	1.2
Sand and gravel	2.3	1.8	3.5	2.9	3.7
Wall plaster and wall board	2.5	2.4	2.7	3.7	2.4
Materials not classified	1.1	1.2	.8	.9	.8

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Welded Building Construction Costs

GILBERT D. FISH
Consulting Engineer, New York City

WHEN CONSIDERING the question of costs of welded building frames there are a number of fundamental facts to be appreciated. A brief listing of these facts, as a background for the discussion to follow, will be useful:

After fourteen years experience with arc welding of steel-frame buildings, the unit costs of the welding operations in shop and field can be estimated as accurately as any other labor item in construction.

The conflicting views that still persist as to relative costs of welded and riveted structures are due mainly to wide variations in economy of design and efficiency of execution of welded framing.

In all-welded new construction, as distinguished from alterations, the welding item should cost slightly less than riveting, whereas in reinforcing or making connections to old steel, welding is incomparably cheaper than drilling holes and riveting or bolting.

In new work, the steel saving due to welding is always in its favor but varies from as little as 3 per cent of total weight to 15 per cent or even more, having a value generally between 2 and 8 per cent of total cost of erected steel.

As extra design engineering and more expensive inspection usually accompany welded construction, the conventional tier building (which offers a minimum of opportunities to save steel by welding) costs very slightly less if welded, when the work is properly handled but not otherwise. On the other hand, a building requiring many plate girders, trusses, long beams of restricted depth, extensive or heavy wind bracing, bracketed or highly eccentric column connections, etc., offers special advantages to welding.

Riveting vs. welding

As a key to the study of welded building costs, but not as a set of values to be used for estimating contracts, two hypothetical building frames may be considered. The location is assumed to be in New York City; in other localities, field costs would generally be lower. Building A is a simple beam-and-column job of moderate height, medium spans, no wind bracing, no built-up members, no continuous beams or rigid-frame elements. Whether riveting or welding is used, beam-to-beam connections are permitted to be field bolted. The weight saving by welding instead of riveting is merely the difference between connection weights, 60 tons and 25 tons respectively.

Building A, Riveted

1000 tons steel & freight at $48	$48,000
Fabrication & shop drawings	14,000
Erection (excl. riveting)	14,000
Field riveting	6,000
Commercial overhead & profit	8,000
Total	$90,000

Building A, Welded

965 tons steel & freight at $48	$46,300
Fabrication & shop drawings	14,000
Erection (excluding welding)	14,000
Field welding	5,000
Commercial overhead & profit	8,000
Total	$87,300

The above summaries are assumed to represent a comparison made by a steel company thoroughly experienced in both riveting and welding. The slight saving in favor of welding might easily be wiped out by unskilled design of welded connections, by requiring the contractor to bear the welding inspection cost, by extra expense required if field welding is sublet, etc. The class of framing represented by Building A, which contains no features to bring out the advantages of welding, cannot safely be predicted to show a cost saving by welding unless handled by an organization as familiar with welding as with riveting.

Now consider Building B, having various special features permitting weight savings to be accomplished by intelligent welding design. It is a 2000-ton structure of 20 stories, say an apartment hotel, with several setbacks, considerable wind bracing, a row of plate girders carrying columns at one of the lower tiers, and numerous H columns used as girders to carry short columns in the setback tiers. Assuming riveted connections including wind bracing to weigh 280 tons, riveted plate girders 120 tons and H columns used as girders 40 tons, then welded connections will likely weigh 80 tons, welded plate girders 84 tons and cover-plated beams, to replace the 40 tons of H's, 32 tons, a combined saving of 244 tons or 12.2 per cent. Welded wind bracing saves labor both in shops and field and is supposed to account for the $1000 difference in shop fabrication and about half the $4000 difference between field riveting and field welding in the analysis below.

Building B, Riveted

2000 tons steel & freight at $48	$96,000
Fabrication & shop drawings	32,000
Erection (excl. riveting)	34,000
Field riveting	17,000
Commercial overhead & profit	17,000
Total	$196,000

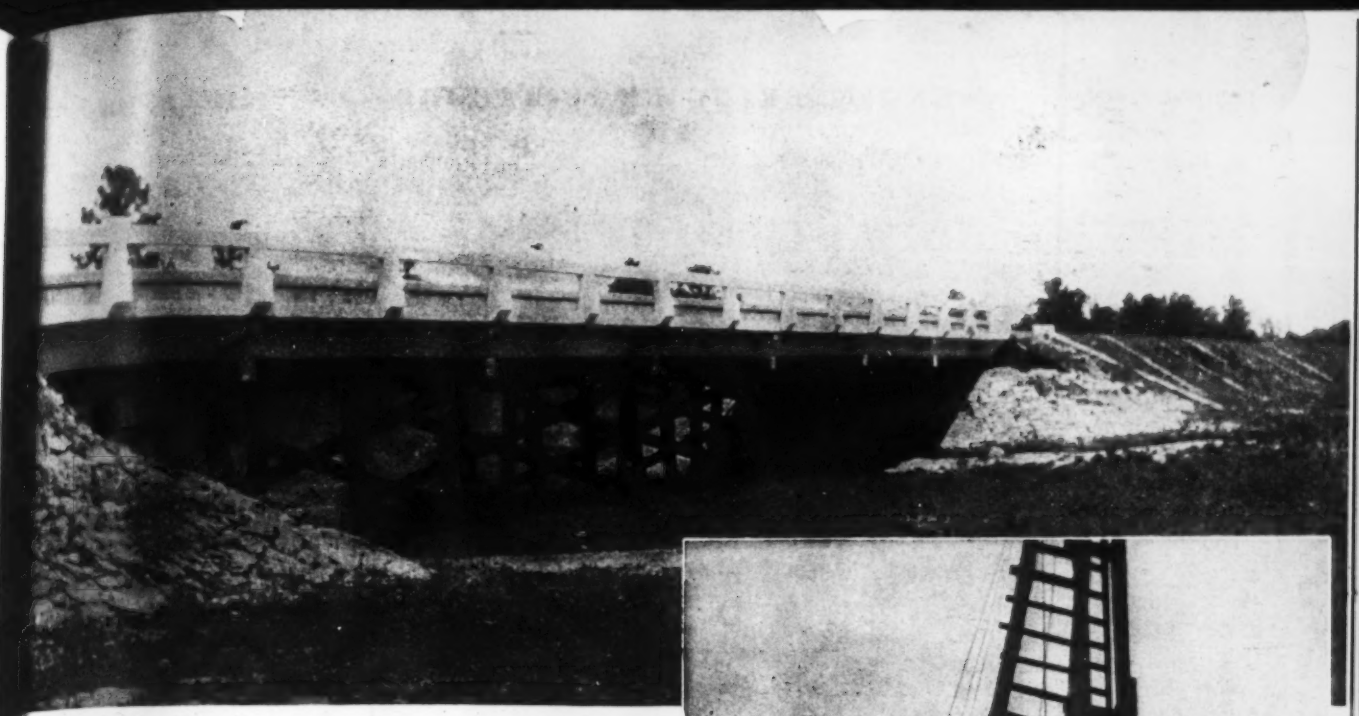
Building B, Welded

1756 tons steel & freight at $48	$84,300
Fabrication & shop drawings	31,000
Erection (excl. welding)	34,000
Field welding	13,000
Commercial overhead & profit	17,000
Total	$179,300

The presence of two or more bidders experienced in welding makes such a job as this difficult to win by a proposal based on riveting. There has in the last few years been a tendency for steel companies, competing for such work and for various reasons wishing to stick to the old methods, to bid lower on account of welding competition. Numerous jobs have been riveted on this account, at prices determined by welding. Although competitive bids, over a long period and on a large number and variety of jobs, yield information as to cost comparisons, they are the most misleading source of data on relative cost of riveted and welded construction.

Welding on connections

For preliminary estimates and for rough appraisal of economy of details, representative quantities of connection material and welding per ton of steel are shown on p. 140, for several classes of building framing. They



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Connection Quantities Per Ton of Steel

Class of Framing	Connection Material	Shop Welding	Field Welding
I. Heavy beam-and-column framing, no built-up members, no continuity, no wind bracing, beam-to-beam connections field bolted	40 lb.....	6 ft. of fillets ¼" to ½", mean size $\frac{5}{16}$".	4 ft. of fillets ¼" to ½", mean size $\frac{5}{16}$".
II. Same as I, except substantially wind braced	70 lb.....	8 ft. of fillets ¼" to ½", mean size $\frac{11}{32}$"	4 ft. of fillets ¼" to ½", mean size $\frac{5}{16}$", plus 1½ ft. 45 deg. butts ¼" to ⅜", mean size $\frac{5}{16}$"
III. Same as I, except light framing (about 13 lb. p. sq. foot incl. columns)	55 lb.....	8 ft. of fillets ¼" to ⅜", mean size $\frac{5}{16}$"	5 ft. of fillets ¼" to ⅜", mean size $\frac{5}{16}$"
IV. Highly irregular, rather light framing of apartment house type, many eccentric connections, nominal wind bracing, no built-up members, filling-in beams field bolted	65 lb.....	10 ft. of fillets ¼" to ⅜", mean size $\frac{5}{16}$"	6 ft. of fillets ¼" to ⅜", mean size $\frac{5}{16}$"

are smaller than should be expected of inexperienced designers, but are by no means difficult to attain.

Plate girders and trusses

In order to estimate quantities, built-up members such as plate girders and trusses, spandrel plates and shelf angles, continuous beams, rigid-frame construction and other special features should be at least approximately designed as to sections and welding. Plate girders are generally 18 to 33 per cent lighter with welding than with riveting and require 18 to 25 ft. of fillet welds per ton, mostly ¼ to ⅜ in. in size; very heavy girders call for larger sizes of welds, especially at the ends, with fewer lineal feet of welding per ton than light ones.

Trusses vary so widely in form, kinds of members and types of joints, that average quantities of detail material and welding are unsafe for estimating; when gusset plates are used, welding is likely to be greatly increased. A welded truss may be expected to weigh 15 to 28 per cent less than a riveted one designed for the same conditions, may require detail material anywhere from two to ten per cent and total welding from 20 up to 40 or even 50 ft. of ¼ to ⅝ in. fillets per ton.

Welding speeds

Representative welding speeds are shown in the table below. They are based on ordinary conditions of structural welding, most of the welds being from 3 to 12 in. long, and they are overall averages with allowance for all common interruptions. Plate work with long continuous welds is done much faster, whereas intermittent welding with fillets 1 to 2 in. long takes longer.

Fillet welding is far more common than butt welding in building work. The table refers to fillet welds but applies fairly well to 40-deg.-bevel butt welds in flat position. Although such a butt weld has a somewhat larger cross section than a fillet of the same "size" (owing to reinforcement and the slight separation of the parts at the root), there is less waste of weld metal and the average volume of effective deposit per hour is greater. Therefore 45 deg. single-bevel butt welds may be grouped with fillets of the same sizes for estimating, while double-bevel butts are regarded as double lengths of single bevel.

Shop welding is performed mostly in horizontal position, i.e. downward. Vertical welding is somewhat slower but it is neither convenient nor necessary to classify the positions for estimating. Field welding is prevailingly vertical but includes considerable horizontal work. It is not customary to distinguish, as there is not much difference in speed and as nearly all experience records are based on size without regard to position. Overhead welding, which is uncommon except in alterations, may be assumed to take twice as much time as vertical or horizontal welding.

Representative Fillet Welding Speeds

Size	Ft. Per Hr.	
In.	Shop	Field
$\frac{5}{16}$	20	14
¼	13	9
$\frac{3}{16}$	10	7
⅜	7	5
½	4¼	3
⅝	2¾	2
¾	2	1½

Summing up the situation

(1) Welding always permits some steel to be saved. If no main members are designed lighter than for riveting, the saving is limited to the connections but is rarely less than 3½ per cent of total steel and may run to 10 per cent. Plate girders, trusses, cover-plated beams, cantilevers, continuous beam or rigid-frame construction, and other special features provide opportunities for skillful welding design to save very substantial quantities of steel. Contrary to frequently expressed belief, heavy rather than light framing is most favorable to welding economy.

(2) The value of steel saved is at least equal to the mill price plus the freight. There may be additional value in such saving but, if there are economies in labor, these are not due in any considerable amount to the weight reduction.

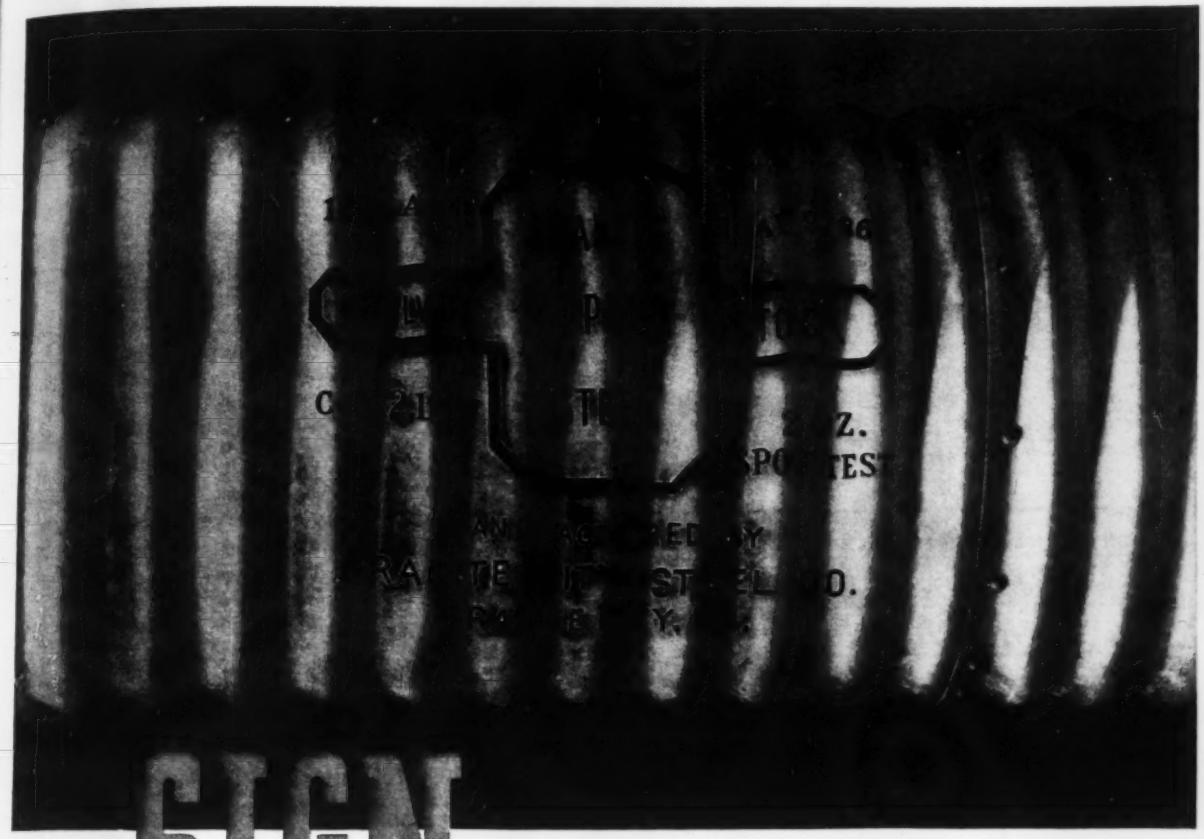
(3) In fabricating shops experienced in and favorably disposed toward welding, costs of welding fabrication are about the same as or slightly less than costs of riveted work. Where there is much less tonnage than would be required for riveting, as in plate girders and most trusses, the fabricating costs *per ton* are a little higher for welding. If the shops were to discard all equipment used in riveted work but not used in connection with welding, and discontinued charging welded work with overhead expense which does not belong to it, they would find welding definitely less expensive than punching, drilling and riveting.

(4) Field welding, if not overdesigned or awkwardly arranged, can be done with fewer hours of labor than field riveting. Contractors who sublet field welding but do their own field riveting find no saving in field costs except in making connections to or reinforcing old steel.

(5) The expense of shop and field inspection is greater for welding than for riveting, probably two to one; an extra cost of 75 cents per ton is quite common.

(6) Any one of numerous steel contractors is willing, barring special circumstances, to quote somewhat lower on welding than on riveting for steel construction of all kinds, provided they are not handicapped by prescribed connection details of uneconomical design. On the other hand, certain companies with large investment in equipment designed for riveted work are reluctant to concede price advantages to welding and find it inconvenient to run welded jobs through shops engaged mainly in riveting.

(7) The trend is toward welding but has been retarded by the prolonged depression in construction. A shortage of steel would be likely to increase sharply the proportion of welded construction.



THE SIGN OF A BETTER CULVERT

The Granite City stencil on galvanized culvert stock is positive assurance that you are buying dependable strength and endurance. You can be sure that your culverts will give unusually long life, because they are made of a tough base metal carefully produced under rigid laboratory control, and evenly coated with a generous weight of spelter that won't peel or chip.

The Granite City Steel Company takes especial pride in the uniform high quality of its culvert stock, and stands behind every sheet with a written guarantee. When you buy culverts, insist on one of the three Granite City Trade Marks: Granite Copper Steel, Granite Copper Iron or Granite Pure Iron.

GRANITE CITY STEEL COMPANY

GRANITE CITY SINCE GRANITE CITY SHEETS 1878 **ILLINOIS**

Chicago • Cleveland • Denver • Indianapolis • Kansas City • Los Angeles • Louisville
Memphis • Milwaukee • Minneapolis • Moline • New Orleans • New York • St. Louis

Federal Building Cost Index

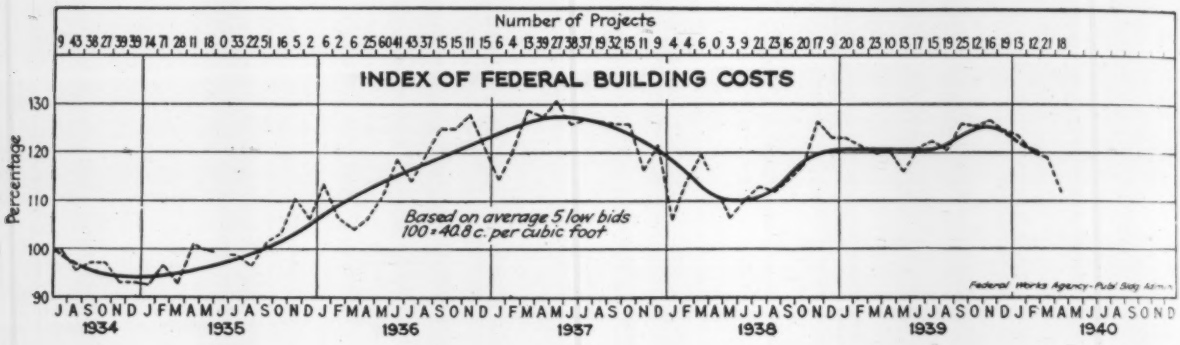
THE INDEX of federal building costs in the chart is based on bids received on 1,445 similar buildings, mostly post offices, costing approximately $45,000 each. They are fireproof structures of bearing wall and steel column construction with concrete ground floors. Design is for office occupancy.

The cost used is the average of the five low bids on the general contract. It includes all labor and material cost of building the structures, complete with plumbing, heating and wiring. Land, architect's fees, furniture, etc., are not included.

The points on the jagged line represent the average of all bids opened during the month. The figures at the top of the chart are the number of projects involved. It is stated that the maximum range in cost of individual buildings in a given month has been about 15 per cent.

The smooth curve has been obtained mathematically, weighting the points on the jagged curve according to the number of buildings.

Excellent correlation between the curve and costs of large buildings has been found, according to LeRoy Barton, architectural advisor to the Public Buildings Administration, who compiled the data used in the chart. The curve has been used before Congressional committees for several years to justify Public Buildings Administration appropriations.


Number of Projects
9 43 38 27 39 39 74 71 28 11 18 0 33 22 51 16 5 2 6 2 6 25 60 41 43 37 15 15 11 15 6 4 13 39 27 38 37 19 32 15 11 9 4 4 6 0 3 9 21 23 16 20 17 9 20 8 23 10 13 17 15 19 25 12 16 19 13 12 21 18
INDEX OF FEDERAL BUILDING COSTS
Percentage
130
120
110
100
90
Based on average 5 low bids
100 = 40.8 c. per cubic foot
Federal Works Agency - Publ. Bldg. Admin.
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1934
1935
1936
1937
1938
1939
1940

Equipment Rental Prices In Five Areas

Upper Ohio Valley

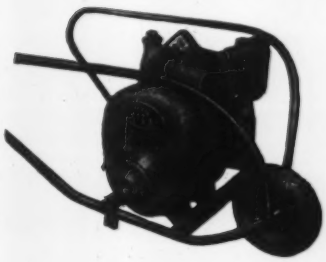
Item	Price per Month*
Backfiller	$250.00
Bins:	
Two comp., 50 ton	150.00
100 ton weigh batchers	250.00
Boilers, 40 hp	75.00
Buckets:	
Conc. contr. dump, 1 yd	35.00
Conc. contr. dump, 2 yd	50.00
Conc. tipover type, 1 yd	20.00
Clamshell, ¾ yd	90.00
Clamshell, 1 yd	115.00
Clamshell, 1½ yd	150.00
Dragline, 1 yd	115.00
Dragline, 1½ yd	150.00
Dragline, 2 yd	175.00
Orange peel, 1 yd	150.00
Cars, dump:	
4 yd	30.00
6 yd	50.00
12 yd	60.00
20 yd	100.00
30 yd	125.00
Chain falls, 5 ton	50.00
Compressors:	
Port. gas, 160 ft	225.00
Port. gas, 210 ft	275.00
Port. gas, 315 ft	400.00
Sta. 20x12, 100 hp., no power	150.00
Chutes, cone, 30 ft	10.00
Column clamps:	
36 in	.25
60 in	.35
Conveyor, belt:	
Gas or elec., 16 in., 32 ft	100.00
Gas or elec., 24 in., 32 ft	125.00
Cranes:	
Gas crawler, ¾ yd	500.00
Gas crawler, 1 yd	550.00
Gas crawler, 1½ yd	650.00
Locomotive, 20 ton	600.00
Derricks, steel:	
Stiffleg, 5 ton, 50 ft. bm	100.00
Stiffleg, 10 ton, 70 ft. bm	200.00
Guy, 5 ton, 50 ft. bm	100.00
Guy, 20 ton, 80 ft. bm	225.00
Drills, pneu. rock:	
Jackhammer	30.00
Wagon drills	125.00
Engine, gas:	
5 hp	20.00
15 hp	40.00
60 hp	80.00
Graders, road:	
Drawn, lean, wheel, 6,500 lb	135.00
Drawn, lean, wh., 11,000 lb., pow. contr.	250.00
Motor patrol, up to 12,500 lb	300.00
Motor patrol, over 12,500 lb	350.00
Hoists:	
Elec., 2 drum, 20 hp	70.00
Elec., 2 drum, 40 hp	125.00
Elec., 2 drum, 60 hp	150.00
Elec., 2 drum, 100 hp	200.00
Gas, single drum, 20 hp	80.00
Gas, single drum, 40 hp	110.00
Gas, single drum, 60 hp	135.00
Lighting units:	
Carbic	10.00
Locomotives:	
Gas or diesel, 6–8 ton	200.00
Gas or diesel, 10 ton	250.00
Gas or diesel, 12 ton	300.00
Gas or diesel, 15–18 ton	450.00
Gas or diesel, 20 ton	600.00
Gas or diesel, 25 ton	750.00
Steam, 13x18, 14x20	400.00
Steam, 16x24, 18x24	500.00
Mixers:	
Power loader, 7-S	85.00
Power loader, 14-S	135.00
Power loader, 21-S	165.00
Batch hopper, 28-S	195.00
Batch hopper, 56-S	350.00
Paver, 27-E	500.00
Pile hammers:	
Union #6, McKiernan-Terry #2	60.00
Union #4, McK-T #5	100.00
Union #2, McK-T #7	150.00
Vulcan #1	200.00
Union #1, McK-T #9B2	200.00
Union #00, McK-T #11B2	275.00
Piledriver hanging leads, steel 50 ft	35.00
Pumps:	
Steam, 6 in., 1,150 gpm	85.00
Steam, 8 in., 2,000 gpm	125.00
Gas or elec., pressure, 30 gpm	55.00
Gas or elec., pressure, 40 gpm	65.00
Triplex, 100 gpm	150.00
Gas centrifugal, 2 in	40.00
Gas centrifugal, 3 in	50.00
Gas centrifugal, 4 in	75.00
Elec. centrifugal, 6 in	115.00
Hand diaphragm, 4 in	12.50
Power diaphragm, 4 in	40.00
Road finishing machines:	
9–20 ft	275.00
24–30 ft	350.00
Road forms:	
8–9 in. per ft	.10
10 in., per ft	.125
Road rollers:	
Gas, 3 wheel, 10 ton	225.00
Gas, 3 wheel, 12–15 ton	275.00
Gas, tandem, 5 ton	175.00
Gas, tandem, 8 ton	200.00
Gas, tandem, 10 ton	225.00
Road subgraders:	
9–12 ft	50.00
15–20 ft	75.00
24–30 ft	150.00
Saws:	
Table, 8 hp. eng., two saws	50.00
Elec. hand, 8 in	40.00
Scrapers:	
Rollover, 27 c.f	40.00
Rollover, 56 c.f	125.00
Shores, each	.25
Shovels, gas crawler:	
½ yd	450.00

WHAT'S YOUR PUMPING PROBLEM?

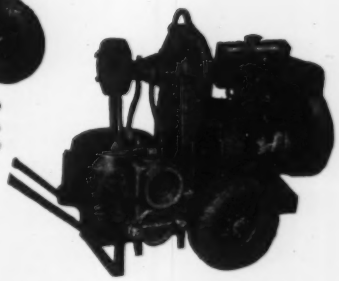
Here is the Answer

Novo 4" Self-primer on bridge job. Capacity: 40,000 GPH.

All of these Novo Pumps comply with the A. G. C. Standards and bear their rating plate.



Novo 2" Self-primer, 10,000 GPH, with pneumatic wheels and hoisting sling. (One of 10 sizes available.)



Novo lift-and-force Diaphragm Pump built in 3" and 4" sizes, 3,000 and 6,000 GPH respectively.

Novo Road Pump (Triplex Power Pump). Highest efficiency — easy portability.

THE right answer for de-watering is Novo Self-priming Centrifugal Pumps and Novo Diaphragm Pumps.

NOVO SELF-PRIMERS have a hydraulic air seal on the impeller shaft, accomplished by simply submerging the impeller in water under pressure from the discharge. Water is kept from leaking around shaft by a greaseless packing that requires no attention. There are two adjustable wear-plates, one on either side of the impeller. You can get at wear-plate and impeller by just removing outer pump plate.

These features mean long, efficient performance and easy adjustment when it becomes necessary. 10 sizes, 1½" to 8", gasoline and electric powered.

NOVO DIAPHRAGM PUMPS have been modernized in design but still operate on that good old fool-proof principle that you know will not fail you in the pinches where dirty, mucky, or sand-ladened water is to be handled.

Novo Diaphragm Pumps are the lift-and-force type that have been designed for greatest pump efficiency and easy portability without the excess weight you use to think necessary in diaphragm pumps. Gears and bearings flooded with oil. Clean-out plate on discharge. Send the coupon.

NOVO ROAD PUMPS (Triplex Power Pumps) have a high efficiency never before attained in pressure pumps of this type. The reasons are: There are only two reductions between the power unit and pump crankshaft. A multiple roller chain and herring-bone gears (running in oil) transmit power efficiently and quietly. Crankshaft and pinion shaft are mounted on large roller bearings. The whole pump is streamlined with a low center of gravity. Sizes: 80 GPM at 500# pressure, 100 GPM at 600#, 125 GPM at 500#, 150 GPM at 400#.

ENGINES - PUMPS - HOISTS - LIGHT PLANTS

NOVO ENGINE COMPANY
LANSING, MICHIGAN

NOVO ENGINE COMPANY, 200 Porter St., Lansing, Mich., U.S.A.
Send information on: NOVO Self-primer ☐ NOVO Diaphragm ☐ NOVO Road Pump ☐ NOVO Hoists ☐ NOVO Light Plants ☐

Name.....
Address.....
City.....
State.....

¾ yd	550.00
1 yd	650.00
1¼ yd	700.00
1½ yd	750.00
Tractors:	
30 hp. bare	175.00
30 hp bulldozer	250.00
50 hp bare	250.00
50 hp. bulldozer	300.00
75 hp bare	450.00
75 hp. bulldozer	650.00
Trench brace, dos	6.00
Trenching machine	500.00
Wagons, crawler dump, 5–8 yd	125.00
Welding machines:	
200 amp	125.00
300 amp	150.00

* Note: Prices are generally minimums; some items subject to discount for rental periods over one month; prices for one shift 10 hr or less per day, add 50 per cent for extra shift: 100 per cent for 24-hr. service

New England

Item	Price per Month
Aggregate bin and batcher:	
85 tons—with scales	$200.00
125 tons—with scales	350.00
Boilers:	
Up to 60 hp	75.00
60–100 hp	175.00
Buckets, clamshell or dragline:	
¾ yd	70.00
1 yd	90.00
1½	90.00
Compressors:	
Port. gas 60 ft	110.00
Port. gas 160 ft	275.00
Port gas 210 ft	300.00
Port. gas 315 ft	350.00
Add for Diesel power	75.00
Conveyors, belt:	
Conc. crawler	300.00
Conc. wheel	175.00
Cranes and shovels:	
Gas crawler ¾ yd	450.00
Gas crawler 1 yd	550.00
Gas crawler 1½ yd	800.00
Gas crawler 2 yd	1,200.00
Add for Diesel power	75.00
Derricks, stiffleg:	
Price range	75.00 to 550.00
Drills, pneu. rock:	
Jackhammer	35.00
Wagon drills	150.00
Engines, gas:	
4 hp	75.00
8 hp	125.00
50 hp	175.00
100 hp	300.00
Graders, power:	
Under 20 hp	200.00
20–40 hp	300.00
40 hp. and over	450.00
Mixers, concrete:	
½ bag	75.00
1 bag	100.00
2 bag	125.00
Paver-27-E	550.00
Paver-double drum	1,550.00
Pumps:	
Centrifugal self-priming 2-in	70.00
Cent. s.p. 3-in	75.00
Cent. s.p. 4-in	85.00
Cent. s.p. 6-in	150.00
Hand pump	32.00
Wellpoint pump—up to 6-in	200.00
Road finishing machines:	
Ord, Lakewood or equal	400.00
Road forms:	
Steel—per 1,000 l.f	100.00
Road rollers:	
Gas—tandem 1½ ton	140.00
Gas—tandem 7–10 ton	225.00
Gas—3 wheel 10–14 ton	225.00
Steam—10 ton	160.00
Tractors:	
30 hp. bulldozer	325.00
50 hp. bulldozer	440.00
75 hp. bulldozer	600.00
Trailers, scrapers:	
Bottom dump semi trailer 8-yd. per hr.	$4.00
Bottom dump semi trailer 10-yd. per hr.	$5.00
Carryall and tractor 8-yd. per hr.	$8.00
Carryall and tractor 12-yd. per hr.	$10.00
Koehring trail dump	400.00
Vibrators:	
Concrete vibrator	125.00
Welding machine:	
Port. machine	550.00

Philadelphia Area

Item	Price per Month
Aggregate bin and batcher:	
85 tons — with scales	$200.00
125 tons — with scales	300.00
Backfiller	150.00
Bins:	
Two compartments 50 ton	150.00
Two compartments 100 ton	225.00
Boilers — vertical:	
40 hp	85.00
60 hp	100.00
100 hp	150.00
Buckets:	
Conc. cont. dump 1 yd	35.00
Conc. cont. dump 2 yd	50.00
Conc. tipover type	35.00
Clamshell ¾ yd	100.00
Clamshell 1 yd	120.00
Clamshell 1½ yd	160.00
Dragline 1 yd	115.00
Dragline 1½ yd	150.00
Dragline 2 yd	175.00
Orange peel 1 yd	150.00
Cars, dump:	
4 yd	30.00
Compressors:	
Port. gas, 160 ft	175.00
Port. gas, 210 ft	225.00
Port. gas, 360 ft	300.00
Cranes:	
Gas crawler, ¾ yd	750.00
Gas crawler, 1 yd	775.00
Gas crawler 1½ yd	1,000.00
Gas crawler 2 yd	1,250.00
Locomotive, 20 ton	500.00
Derricks, steel:	
Stiffleg, 5 ton, 50 ft. bm	150.00
Stiffleg, 10 ton, 70 ft. bm	150.00
Guy, 5 ton, 50 ft. bm	150.00
Guy, 20 ton, 80 ft. bm	200.00
Drills, pneu. rock:	
Jackhammer	35.00
Wagon drills	125.00
Hoists:	
Elec., 2 drum, 20 hp	90.00
Elec., 2 drum, 40 hp	125.00
Elec., 2 drum, 60 hp	170.00
Elec., 2 drum, 100 hp	210.00
Gas, single drum, 20 hp	75.00
Gas, single drum, 40 hp	100.00
Gas, single drum, 60 hp	140.00
Mixers:	
Power loader, 7-S	90.00
Power loader, 14-S	160.00
Power loader, 21-S	175.00
Batch hopper, 28-S	200.00
Batch hopper, 56-S	300.00
Paver, 27-E	650.00
Pile hammers:	
Union #6, McKiernan-Terry #2	90.00
Union #4, McK-T #5	120.00
Union #2, McK-T #7	168.00
Vulcan #1	200.00
Union #1, McK-T #9B2	240.00
Union #00, McK-T #11B2	300.00
Pumps:	
Gas or elec., pressure, 30 gpm	150.00
Gas or elec., pressure 40 gpm	150.00
Triplex, 100 gpm	200.00
Gas centrifugal, 2 in. plus hose	50.00
Gas centrifugal, 3 in	75.00
Gas centrifugal, 4 in	100.00
Elec., centrifugal, 6 in	150.00
Power diaphragm, 4 in. single diaphragm	50.00
Road finishing machines, 9–20 ft	300.00
Road forms:	
8–9 in. per ft	.125
10 in., per ft	.15
Road rollers:	
Gas, 3 wheel, 10 ton w/o scarifier	250.00
Gas, tandem, 5 ton	150.00
Gas, tandem, 8 ton	250.00
Gas, tandem, 10 ton	250.00
Road subgraders:	
9–12 ft	750.00
15–20 ft	1,000.00
24–30 ft	1,250.00
Saws:	
Table, 8 hp. eng., two saws	50.00
Elec. hand, 8 in	30.00
Scrapers:	
Rollover, 27 c.f	35.00
Rollover, 56 c.f	75.00
Shovels, gas crawler:	
½ yd	600.00
¾ yd	750.00
1 yd	775.00
1¼ yd	850.00
1½ yd	1,000.00

Tractors:	Gas	Diesel
30 hp. bare	$225.00	$375.00
30 hp. bulldozer	275.00	425.00
50 hp. bare	350.00	475.00
50 hp. bulldozer	425.00	550.00
75 hp. bare	450.00	625.00
75 hp. bulldozer	550.00	750.00

Trenching machines — depends on size and No. of months	$350-450
Wagons, crawler dump, 5–8 yd	100.00
Welding machines:	
200 amp	125.00
300 amp	150.00

New York City

Item	Price per Month
Buckets:	
Clamshell bucket ½ yd	150.00
Compressors:	
Port. gas, 160 ft	175.00
Port. gas, 210 ft	195.00
Port. gas, 315 ft	220.00
Drills, pneu.:	
Jackhammer	30.00
Clay digger	40.00
Gasoline generators:	
1.8 Kw d. c	100.00
5 Kw d. c	120.00
Hoists:	
Elec., 2 drum, 20 hp	65.00
Elec., 2 drum, 40 hp	130.00
Elec., 2 drum, 60 hp	160.00
Elec., 2 drum, 100 hp	205.00
Gas, single drum, 20 hp	65.00
Gas, single drum, 40 hp	110.00
Gas, single drum, 70 hp	140.00
Mixers:	
Power loader, 7-S	85.00
Power loader, 14-S	130.00
Power loader, 21-S	175.00
Batch hopper, 28-S	175.00
Pile hammers:	
McKiernan-Terry #2	80.00
McK-T #5	110.00
McK-T #7	175.00
Vulcan #1	325.00
McK-T #9B2	250.00
McK-T #11B2	540.00
Pumps:	
Gas centrifugal, 2 in	50.00
Gas centrifugal, 3 in	65.00
Gas centrifugal, 4 in	85.00
Elec., centrifugal, 6 in. 25 hp	130.00
Power diaphragm, 4 in	65.00
Saws:	
Rex #5 saw rig	105.00
Skilsaw Model E	75.00
Vibrator:	
Gasoline driven, with 24′ core and casing and 2¾ x 18 in. head	110.00
Welding machines:	
300 amp. gasoline driven	150.00
300 amp. electric driven	110.00

St. Louis Area

Boilers:	
40 hp	70.00
60 hp	80.00
100 hp	100.00
Buckets:	
Clamshell ¾ yd	75.00
Clamshell 1 yd	90.00
Clamshell 1½ yd	100.00
Dragline 1 yd	85.00
Dragline 1½ yd	110.00
Compressors:	
Port. gas, 160 ft	200.00
Port. gas, 210 ft	300.00
Port. gas, 360 ft	400.00
Cranes and shovels:	
Gas crawler, ¾ yd	400.00
Gas crawler, 1 yd	450.00
Gas crawler, 1½ yd	700.00
Gas crawler, 2 yd	1,000.00
Locomotive, 20 ton	450.00
Derricks:	
Steel guy derrick, 20 ton, 80 ft. bm	150.00
Engines gas:	
5 hp	10.00
15 hp	25.00
60 hp	80.00
Hoists:	
Elec., 2 drum, 20 hp	60.00
Elec., 2 drum, 40 hp	135.00
Elec., 2 drum, 60 hp	150.00
Elec., 2 drum, 100 hp	150.00
Gas, single drum, 20 hp	75.00
Gas, single drum, 40 hp	125.00
Gas, single drum, 60 hp	175.00
Locomotives:	
Gas or diesel locomotive, 20 ton	500.00
Pile hammers:	
Union #4, McK-T #5	60.00
Union #2, McK-T #7	100.00
Vulcan #1	125.00
Union #1, McK-T #9B2	175.00

FAST INSTALLATION at low cost featured this Transite sewer line at Pearl River, N. Y. Because of Transite's light weight and long lengths, 18" gravity lines were easily and accurately laid. *Sanborn & Bogert, Engineers. Kuchar Bros.* and *Pepper Bros., Contractors.*

Elimination of concrete cradle, unusually rapid installation and tight joints effect important savings on this Transite sewer line at Pearl River, N. Y.

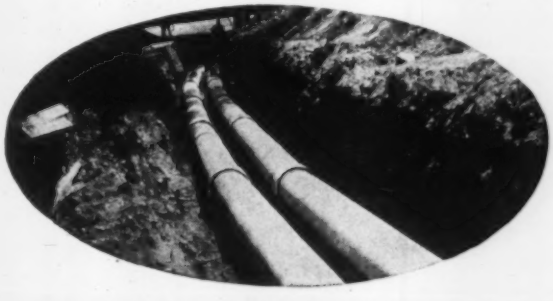
TRENCHES up to 26 feet in depth . . . four siphons in the main trunk line, two of which were over 2400 feet long . . . these were two of many unusual conditions on the Pearl River sewer line.

To meet these requirements, Sanborn & Bogert, Engineers, selected 18,000 feet of J-M Transite Pipe. Because of its uniform strength and durability, this modern pipe safely withstands the weight of heavy backfill *without a concrete cradle!*

On the 18" gravity line, Transite's relatively light weight and long 13-foot lengths made possible a fast, accurate laying job under exacting conditions. On siphons, where the contractors originally hoped to install 500 feet per day, they actually laid as much as *3200 feet of 14" Transite Pipe in one day.*

But installation savings aren't the whole story of Transite Pipe. Made of asbestos and cement, it is highly resistant to all forms of corrosion. Maintenance is practically zero. Joints are tight to begin with . . . and they *stay* tight. And Transite's smooth interior surface (n=.010) frequently makes possible flatter grades, shallower trenches or smaller pipe without sacrifice of carrying capacity.

If you are planning new sewer lines or extensions to your present system, why not get the facts on this modern sewer pipe? Write for brochure TR-21A. And for facts on Transite Pipe for better water lines, send for brochure TR-11A. Johns-Manville, 22 East 40th Street, New York, N. Y.



ONE OF FOUR inverted siphon sections in the Pearl River sewer system. Using 14" Transite Pressure Pipe with Simplex Couplings, Pepper Bros., Contractors, were able to lay more than 3200 feet of pipe in one day.

JOHNS-MANVILLE TRANSITE PIPE

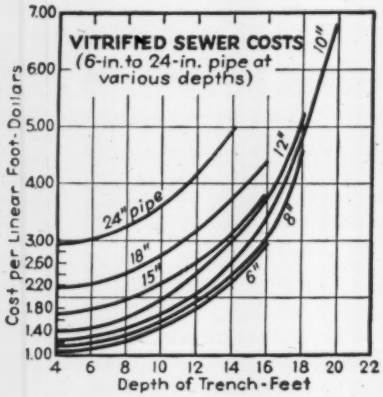
The MODERN Material for Sewer and Water Lines

Sewer Pipe Costs

MORGAN W. HAYES and
I. W. MENDELSOHN

FOR THE PURPOSE of obtaining cost data on recent PWA sewerage projects, an analysis was made of a number of jobs in New York state, all but one of which were let for construction in the latter part of 1938. This group of projects was chosen because of its location in a large industrial state, typical of the New England and Middle Atlantic regions, where freight rates, wage rates and material prices are comparable. A summary of actual bid prices on twenty-four vitrified clay sewer pipe installations is given in Table I, and a graphic presentation of the data is shown below.

The pipe sizes range from 6 to 24 in. and the depth of trench varies from 6 to 18 ft. The unit costs that have been summarized include the cost of furnishing the pipe as well as the excavation, laying and backfilling charges.



An examination of curves in the chart shows that as the depth of trench increases, the curves for the different size pipes tend to come together. A reasonable conclusion from this would indicate that as the trenches deepen, the cost of excavation assumes the greatest weight and the differences in cost for the different size of pipe are less apparent as they are absorbed in excavation.

Table II—HOURLY LABOR RATES ON PWA SEWER PROJECTS IN NEW YORK STATE

Location	Section	Common Labor	Bricklayer	Pipe Layer	Machine Operator
Elmira	South-central	0.50	1.50	0.60	1.25
Hempstead, L.I.	New York city zone.	0.75	1.89	0.75	1.25
Hudson Falls.	North-eastern.	0.50	1.25	0.65	1.12½
Youngstown.	North-western	0.50	1.50	0.65	1.50

NOTE. The price per foot of vitrified sewer pipe, single strength, delivered in New York City in December, 1938, was $0.29 for 8 in. and $0.57 for 12 in. pipe.

TABLE I — UNIT COST DATA ON TYPICAL PWA SEWER PIPE INSTALLATIONS IN NEW YORK STATE

These unit costs on clay sewer pipe installations made under PWA supervision include the cost of furnishing pipe, as well as the excavation, laying and backfilling charges.

Location	6 in. Pipe					8 in. Pipe						10 in. Pipe						12 in. Pipe						15 in. Pipe						18 in. Pipe					
	Depth of Trench																																		
	6'	8'	10'	12'	14'	16'	6'	8'	10'	12'	14'	16'	18'	6'	8'	10'	12'	14'	16'	18'	6'	8'	10'	12'	14'	16'	18'	6'	8'	10'	12'	14'	16'	18'	8'	10'	12'	14'	16'	18'
Schuylerville							1.59	1.72	1.79	1.84	1.88	1.98		1.62	1.72	1.78	1.88	1.98	2.08	2.46																		
Watervliet									1.70	1.90	2.30	2.50	2.90						2.80	3.30																	
Hempstead								1.20	1.20	1.60	2.50					1.40	1.80	2.50						2.00			3.70					3.50	4.00	4.30				5.50
Peru	1.40	1.40	1.80	1.90	1.90	1.90	1.50	1.50	1.90	2.00	2.00	2.00	3.00	1.70	1.70	2.10	2.20	2.20	2.20																4.00	4.50	
Carmel		1.10																																			
Wallkill	.85	.90	1.08	2.30	3.25	4.40	.95	1.00	1.18	2.40	3.35	4.50	6.50	1.10	1.15	1.33	2.55	3.50	4.65	6.65	1.25	1.30	1.48	2.70	3.65	4.80	6.80											
South Fallsburg							1.00	1.00	1.00	1.65	1.65	1.65		1.15	1.45	1.45	2.00	2.00	2.00		1.30	1.60	1.60	2.00	2.00	2.00											
Bethlehem							1.00	1.20	1.50	2.00	3.00	4.00		1.20	1.40	1.70	2.20	3.00	4.00	5.00	1.40	1.60	2.00	2.50	3.00	4.00											
Hempstead							1.08	1.08	1.53	2.00	2.33	2.33		1.69	1.69	1.69	2.16					2.30	2.30	2.30	2.63	2.63											
Manchester		1.40					1.00	1.15	1.50	1.85	5.00	6.00		1.50	1.35	2.00	2.30	3.40	6.00		1.60	1.60	2.00	2.75	7.00							3.50	3.50	3.50			
Shortsville							1.00	1.15	1.50	1.75	2.50	3.40	5.00	1.20	1.35	1.75	2.30	3.00	3.75	5.00	1.40	1.60	2.00	2.75	3.50	5.00											
Hudson Falls								1.20						1.40							1.45							1.70									
Tarrytown							1.30	1.47	1.50	2.00	2.50	3.00		1.25	1.50	1.75	2.00	2.50	3.00		1.50	1.75		1.75	2.25	2.75	3.25	4.00	1.75	2.00	2.25							
Chatham							1.10	1.50	1.75	2.50	3.50																		1.75	2.00	2.10	2.50	2.75	4.25		2.45	2.70	3.00	3.30	3.50	3.65
Cortland	1.00	1.40	1.65	2.40	3.40		1.30	1.47	1.50	2.00	2.50	3.00		1.25	1.50	1.75	2.00																					
Stillwater							1.00	1.00	1.00	1.00	1.50	4.00		1.25	1.50	1.75	2.00					1.50	1.75	2.25														
Youngstown							.90	1.00						1.25	1.50	1.50	2.00	2.00	4.00		1.50	2.00	2.00	2.00	2.00	4.00											
Elmira																					1.40	1.60	2.00														
Livonia							.80	.80	.85	.90	1.50	2.00	3.50	1.25	1.00	1.00	1.20	3.00	4.00	5.00	1.25	1.50	3.00	4.00													
Rockville Center							1.00	1.25	1.50	1.75	2.25					1.50	1.75	2.50	3.00					2.50	2.75	3.50											
Yonkers																												1.75	2.00	2.25	2.25	2.25						
Yonkers																												2.21	2.42	2.62							4.00	4.15	4.25
Yonkers																																						
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